

The *levis* group of *Orthemis* revisited: a synopsis including a synonymy and description of six new species of *Orthemis* from South America (Odonata: Libellulidae)

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The *levis* and *ferruginea* groups of *Orthemis* are redefined. Six new species of *Orthemis* are described: *O. aciculata* sp. nov. (♂ holotype: Surinam, Para Dist., road near forest, Zanderij I (5°32' N, 55°10' W), 17 January 1957, leg. J. Belle [RMNH]), *O. celata* sp. nov. (♂ holotype: Brazil, Pará State, Rio Gurupí, Canindé (0°30'57" S, 51°14'00" W), 27–28 February 1966, leg. B. Malkin [RMNH]), *O. faaseni* sp. nov. (♂ holotype: Brazil, Rondônia State, Porto Velho (8°46' S, 63°54' W), 28 February 1922, leg. J.H. Williamson & J.W. Strohm [UMMZ]), *O. garrisoni* sp. nov. (♂ holotype: Panama, Panamá Prov., 7 km NW of Gamboa, Pipeline Road, trail near palm forest, 30 July 1979, leg. RWG & J.A. Garrison [FSCA]), *O. paulsoni* sp. nov. (♂ holotype: Ecuador, Sucumbíos Prov., forest trail ca. 3 km W of Shushufindi (0°09'59" N, 76°41'30" W), 14 October 2009, leg. K.J. Tennessen [FSCA]), and *O. teres* sp. nov. (♂ holotype: Bolivia, Cochabamba Dept., Chapare, Cristal Mayo (17°00'57" N, 65°38'09" W), October/November 1994, leg. R. Andreas [FSCA]). *Orthemis plaumanni* Buchholz is found to be a junior synonym of *O. ambinigra* Calvert. A lectotype is designated for *O. concolor* Ris. All species of the *levis* group and the new species of the *ferruginea* group described here are diagnosed, illustrated, mapped, and keyed.

Keywords: Odonata; dragonfly; Libellulidae; *Orthemis*; *levis* group; *ferruginea* group; diagnoses

Introduction

Orthemis Hagen, 1861 currently comprises 23 New World species, primarily neotropical in distribution, which have been loosely classified into two groups based on abdominal width (von Ellenrieder, 2009): the *ferruginea* group, whose species are characterized by a robust and depressed abdomen, and the *levis* group, represented by species with a relatively slender abdomen.

Names assigned to species of the *ferruginea* group have been particularly difficult to associate with specimens, and a number of species included within this complex are not yet resolved (Donnelly, 1995, 2001; Paulson, 1998, 2001). Species diagnoses in the *levis* group were originally based mostly on color (i.e. Calvert, 1902; Ris, 1910, 1919). Examination of structural characters of male genitalia showed several specimens with similar color patterns represented different species, leading recently to the description of five new species (von Ellenrieder, 2009).

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After examining over 500 additional specimens from several collections, and borrowing type material of several species whose diagnoses based on original descriptions were not completely reliable, namely *O. ambinigra*, *O. flavopicta*, and *O. plaumanni*, I found *O. ambinigra* to be the senior subjective synonym of *O. plaumanni*, and discovered another five new species of the *levis* group and one of the *ferruginea* group which I describe in this paper. Among the examined material there were several pairs in copula, which allowed the hitherto unknown females of *O. anthracina* and *O. coracina* to be associated with their males, as well as those of *O. cultriformis* and of several of the new species. Based on correlation with male characters I also tentatively describe a female as *O. harpago*. I found the shape of the female vulvar lamina and associated structures to be diagnostic, allowing for species identification of isolated females which thus far was not always possible.

Here I redefine the *ferruginea* and *levis* groups of *Orthemis*, provide a synopsis of the *levis* group, including descriptions of five new species, diagnoses, illustrations, updated maps, an updated key to males, and a partial key to females based on the species described to date, and describe one new species in the *ferruginea* group.

Material and methods

Nomenclature follows Garrison et al. (2006). Measurements are given in millimeters; average dimensions are given as average \pm standard deviation and were taken from 10 specimens when available; Pt length was measured along the costal side, cercus and epiproct length in lateral view, and epiproct maximum and subapical width in ventral view (as indicated in Figure 16a; total length includes appendages and abdomen length excludes them. Width/length ratio of S4 cannot be always measured with exactitude due to the variable degrees at which the abdomen can be artificially compressed (with opposite ventral terga touching, pleura folded under them and sterna entirely hidden) or dilated (with sterna, and sometimes pleura, fully exposed) during preservation; here S4 length was measured along the ventrolateral carina, and S4 apical width at level of the transverse posteroventral carina (as indicated in Figure 6a), and the widest possible range including compressed and dilated states was taken. Specimens in which genital diagnostic characters were not visible were softened in a wet chamber in order to allow spreading of male hamules, extrusion of vesica spermalis from the genital fossa, and unfolding of lateroventral flaps of female S8 using insect pins and watch forceps, then these structures were fixed in the desired position on a piece of balsa wood with minuten pins, and dehydrated in acetone again on the wood before removing the pins. Drawings were made with the aid of a camera lucida coupled to Wild M8 and Nikon SMZ1500 stereomicroscopes. Wings were scanned from specimens.

Short descriptive summaries and diagnoses are provided for species previously known and full descriptions for new species and hitherto unknown females. Species are treated alphabetically. Synonymic lists include only species descriptions, major treatments of the genus, and confirmed misidentifications in the literature, excluding isolated mentions and records. Several of the new species were erroneously assigned to some of the older names in the literature, therefore maps represent distribution records from material examined and type material, and do not include literature records unless confirmed by examination of specimens; they were created electronically from the Digital Chart of the World (1:1,000,000) using Arc View 9.3; longitude/latitude coordinates were culled from the Global Gazetteer website (<http://www.fallingrain.com/world/>) and Google Earth when not provided in the labels.

Acronyms for collectors and collections are as follows: ANSP – Academy of Natural Sciences, Philadelphia, Pennsylvania, USA; BMNH – The Natural History Museum, London, UK; CMNH – Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA; DRP – Dennis R. Paulson,

Seattle, Washington, USA; DZRJ – Department of Zoology, Museum of Rio de Janeiro, Brazil; FSCA – Florida State Collection of Arthropods, Florida, USA; IFML – Instituto y Fundación Miguel Lillo, Tucumán, Argentina; IRSNB – Royal Belgian Institute of Natural Sciences, Brussels, Belgium; JJD – Jerrell J. Daigle, Florida, USA; MIZA – Museo del Instituto de Zoología Agrícola, Maracay, Venezuela; MLP – Museo de La Plata, La Plata, Buenos Aires, Argentina; MZUSP – Museu de Zoologia, Universidade de São Paulo, Brazil; NE – Natalia von Ellenrieder, Sacramento, California, USA; RMNH – Naturalis Collection Leiden, Leiden, the Netherlands; RWG – Rosser W. Garrison, Sacramento, California, USA; TF – Tim Faasen, Maarheeze, the Netherlands; TWD – Thomas W. Donnelly, Binghamton, New York, USA; UMMZ – University of Michigan, Museum of Zoology, Ann Arbor, Michigan, USA; USNM – United States National Museum, Washington DC, USA; ZFMK – Zoologisches Forschungsmuseum Alexander König, Bonn, Germany; ZMHB – Museum für Naturkunde der Humboldt-Universität, Berlin, Germany; ZSM – Zoologische Staatssammlung München, München, Germany.

Results

Redefinition of levis and ferruginea groups of Orthemis

Some previously unknown or incompletely known species seem to bridge the gap between the *levis* and the *ferruginea* groups as previously defined. Hitherto unknown females of *O. anthracina* and *O. coracina* show ranges of the ratio of female epiproct/cerci length overlapping with those purportedly characteristic of the *ferruginea* group (von Ellenrieder, 2009), rendering this character useless for such distinction. S4 width/length ratio of the herein described *O. paulsoni* overlaps with the ranges of abdominal width that I proposed previously (von Ellenrieder, 2009) to separate the *levis* and *ferruginea* groups. Reevaluation of the characters, taking into consideration the new information, allows the two groups to be redefined as follows.

Levis group: Species with S4 apical width/length ratio of 0.56 in male and 0.57 or less in female, and 2–3 rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (Figure 3b). It includes 18 species: *O. aciculata* sp. nov., *O. ambinigra* Calvert, 1909 (= *O. plaumanni* Buchholz, 1950 syn. nov.), *O. ambirufa* Calvert, 1909, *O. anthracina* De Marmels, 1989, *O. attenuata* (Erichson, 1848), *O. celata* sp. nov., *O. cinnamomea* von Ellenrieder, 2009, *O. concolor* Ris, 1919, *O. coracina* von Ellenrieder, 2009, *O. cultriformis* Calvert, 1899, *O. faaseni* sp. nov., *O. flavopicta* Kirby, 1889, *O. garrisoni* sp. nov., *O. harpago* von Ellenrieder, 2009, *O. levis* Calvert, 1906, *O. philipi* von Ellenrieder, 2009, *O. tambopatae* von Ellenrieder, 2009, and *O. teres* sp. nov.

Ferruginea group: Species with S4 apical width/length ratio of 0.59 or more in male and female, and 4 rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (Figure 3a). It includes nine species: *O. aequilibris* Calvert, 1909, *O. biolleyi* Calvert, 1906, *O. discolor* (Burmeister, 1839), *O. ferruginea* (Fabricius, 1775), *O. macrostigma* (Rambur, 1842), *O. nodiplaga* Karsch, 1891, *O. paulsoni* sp. nov., *O. schmidtii* Buchholz, 1950, and *O. sulphurata* Hagen, 1868.

Based on abdominal width I previously placed *O. regalis* Ris, 1910 in the *levis* group (von Ellenrieder, 2009). Based on its S4 apical width/length ratio it would still be classified within the *levis* group, but it shares the presence of four rows of cells between the anal margin of HW and AA2 at the level of the heel of the anal loop with all species in the *ferruginea* group, differing by that character from all species in the *levis* group. Even though the presence of four cells could be correlated with its larger size, its hamular shape, with the ventroposterior corner triangular and projected posteriorly, also approaches that of most species in the *ferruginea* group. This renders it intermediate between the two groups and I exclude it from both.

Even though I believe these two groups could likely be artificial divisions within the genus *Orthemis*, I still use them provisionally for practicality. In order to clarify the relationships among the 28 currently known species of *Orthemis*, and establish whether the *ferruginea* and *levis* groups are natural clades or artificial groups, a phylogenetic analysis including all species in the genus is necessary, which will be possible only after species concepts within the *ferruginea* group have been sorted out.

Diagnostic characters

Depending on the species, combinations of characters such as male epiproct shape and ventral terga contours, coupled with color pattern characters of head, thorax, and abdomen can aid in identification; however, thoracic color pattern may become obscured due to age and/or post-mortem effects (e.g., a reddish brown thorax with yellow stripes may become entirely black in mature males of *O. anthracina*, *O. coracina*, and *O. cultriformis*, entirely dark reddish brown in mature males of *O. levis*, and pruinose blue in mature males of *O. flavopicta*, *O. garrisoni*, and *O. paulsoni*), and abdominal color pattern can be extremely variable in some species (i.e., *O. anthracina*, *O. coracina*, and *O. cultriformis*). Positive identification of the species studied here relies therefore in most cases primarily on morphology of male vesica spermalis and hamule and of the female vulvar lamina. When identifying preserved specimens, this means that in order to properly examine these structures and reach an authoritative identification it is necessary to rehydrate the specimens in order to extrude the vesica spermalis from the genital pocket and move aside the flaps of female S8 which are usually preserved folded over the sternum concealing the vulvar lamina. The marked ventral concavity at the base of male cercus, previously thought to be diagnostic for *O. anthracina* and *O. harpago* (von Ellenrieder, 2009), was found to be of no diagnostic value, since it can be variable, from accentuated to less evident to apparently absent.

Distribution and biology

Several of the species treated here appear to be rare, and are seldom encountered in the field. This is most likely due to their preferred habitats in forested areas of difficult access; their highest species diversity is found in the Amazon region (Figures 21–25). There, it is not unusual to find several species in sympatry; i.e. *O. biolleyi*, *O. cinnamomea*, *O. cultriformis*, and *O. tambopatae* were all collected during a visit to Explorer's Inn in Tambopata in Peru in 2002 [DRP]; *O. aequilibris*, *O. anthracina*, *O. coracina*, *O. cultriformis*, *O. paulsoni*, and *O. schmidt* during a visit to the Tiputini biological station in Ecuador in 2009 [RWG & NE]; *O. aciculata*, *O. anthracina*, *O. biolleyi*, *O. coracina*, and *O. schmidt* during a visit to the Tamshiyacu biological station in Peru in 2009 and *O. attenuata*, *O. faaseni*, *O. cinnamomea*, *O. cultriformis*, *O. discolor* and *O. schmidt* during a visit to the same station in 2010 [RMNH]; and *O. aequilibris*, *O. anthracina*, *O. coracina*, and *O. cultriformis* during a visit to Werehpa in Surinam in 2010 [NE] to mention some examples. Males defend territories from a perch along or on tips of reeds, branches, and snags near ponds, ditches, lakes, and slow moving streams and rivers. Females of some species (e.g., *O. ambinigra*, *O. paulsoni*) were observed ovipositing alone (personal observation), whereas others (in the *ferruginea* group) are usually guarded by the hovering male (Novelo Gutiérrez & González Soriano, 1984; Paulson, 1999). Unfortunately not much is known about their biology, with only larvae of *O. aequilibris*, *O. biolleyi*, *O. levis*, and *O. nodiplaga* described to date (De Marmels, 1990; Fleck, 2003; Rodrigues Capítulo & Muzón, 1990). Larvae that were described as *O. ferruginea* (Needham, 1904; Calvert, 1928; Klots, 1932; Geijskes, 1934) could belong to other species within the *ferruginea* complex.

Key to males of *Orthemis*

Comparison of specimens to descriptions, diagnosis, and figures under a particular species account after using the key is advised before considering identification as final.

1. Wings with extensive dark markings along C-RA space; larger species (Hw > 50 mm); basal sclerotized portion of vesica spermalis deeply constricted medially in ectal view (Figure 13q); Venezuela, Surinam, Brazil, Ecuador, and Peru (Figure 21) *O. regalis*
- 1'. Wings lacking extensive dark markings along C-RA space; smaller species (Hw < 45 mm); basal sclerotized portion of vesica spermalis not deeply constricted medially in ectal view (Figure 13a–p, r–s) 2
2. S4 apical width/length 0.59 or more and 4 rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (Figure 3a) *ferruginea* group 3
- 2'. S4 apical width/length 0.56 or less and 2–3 rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (Figure 3b) *levis* group 4
3. Outer corner of hamule outer branch broadly rounded (Figure 11q) and not projected ventroposteriorly in lateral view (Figure 10p); cerci markedly curved ventrally (Figure 15s, t); Ecuador and Peru (Figure 21) *O. paulsoni*
- 3'. Outer corner of hamule outer branch roundly angled (Figure 11g) and not projected ventroposteriorly in lateral view, to triangular (as in Figure 11s) and projected ventroposteriorly in lateral view (as in Figure 10r); cerci only slightly curved ventrally (Figure 15g) other species in *ferruginea* group
(for diagnoses see De Marmels, 1988; Donnelly, 2001; Meurgey & Daigle, 2007; Paulson, 2001; Ris, 1910)
4. Ventrolateral carina on S4–5 absent (Figures 4f, 6f); vesica spermalis distal segment with distal medial longitudinal lobe entirely sclerotized and spatulate, longer than outer lobe (Figure 12k); N Peru and W Brazil (Figure 20) *O. faaseni*
- 4'. Ventrolateral carina on S4–5 well developed (Figures 4a–e, g–m, 6a–e, g–l); vesica spermalis distal segment with distal medial longitudinal lobe of various shapes and lengths but never entirely sclerotized, spatulate, and longer than outer lobe (Figure 12a–j, l–p, r–t) 5
5. Epiproct apex relatively wide, subapically as wide as 0.50 or more of its basal width (Figure 16a, d, f–h, j, o) 5
- 5'. Epiproct apex relatively narrow, subapically less than 0.45 of its basal width (Figure 16b–c, e, i, k–n, p–r, t–u) 11
6. Hamule inner branch longer than outer branch, extended anteroventrally over ventral margin of hamule in lateral and frontal views (Figures 10n, 11m); Peru and Brazil (Figure 22) *O. harpago*
- 6'. Hamule inner branch shorter than outer branch, not extended over ventral margin of hamule in lateral and frontal views (Figures 10a, d, f, g, i, 11a, d, f, h, k) 7
7. Frons red to reddish brown; labial palp with medial 0.33 or less black (as in Figure 1k); Ecuador and Peru (Figure 23) *O. cinnamomea*
- 7'. Frons metallic blue or metallic purple; labial palp with medial 0.40 or more black (Figure 1c, e–f) 8
8. Inner and outer branches of hamule separated by a distance longer than length of inner branch (Figure 11a); medioectal lobe of vesica spermalis distal segment with a lateral sclerotized splinter-shaped projection directed distally (Figure 13a); Panama, Trinidad, Surinam, N Brazil, and N Peru (Figure 25) *O. aciculata*
- 8'. Inner and outer branches of hamule separated by a distance shorter than length of inner branch (Figure 11d, f, k); vesica spermalis distal segment with medioectal lobe lacking a lateral sclerotized splinter-shaped projection directed distally (Figure 13d, f, i) 9

9. Hamule inner branch parallel to outer branch (Figure 9c), not visible in frontal view (Figure 11f); medioectal lobe of vesica spermalis distal segment lacking a sclerotized lateral projection (Figure 13f); N Brazil (Figure 23) *O. celata*
- 9'. Hamule inner branch curved towards outer branch, visible in frontal view (Figure 11d–k); medioectal lobe of vesica spermalis distal segment with a sclerotized lateral projection (Figure 13d, h) 10
10. Epiproct subquadrate (Figure 16d), with apex as wide as 0.72–0.80 of its maximum width (subapical width 0.8–0.85 mm); basal portion of vesica spermalis distal segment trapezoidal in ectal view (Figure 13d), and medioectal lobe of distal segment distinctly shorter than outer lobe (Figure 12d); ventral terga of S4 longer than three times its apical width (Figure 6c; ratio apical width/length = 0.21–0.31); Venezuela, Trinidad, Surinam, Colombia, and N Peru (Figure 25) *O. anthracina*
- 10'. Epiproct subtriangular (Figure 16j), with apex as wide as 0.50–0.66 of its maximum width (subapical width 0.6–0.66 mm); basal portion of vesica spermalis distal segment parallel sided in ectal view (Figure 13h), and medioectal lobe of distal segment about as long as outer lobe (Figure 12i); ventral terga of S4 as long as ca. twice to three times its apical width (Figure 6e, ratio apical width/length = 0.33–0.48); Surinam, Colombia, Ecuador, N Peru, and Brazil (Figure 25) *O. coracina*
11. Inner corner of outer branch of hamule rounded, not forming a point (Figure 11c, e, i, n) 12
- 11'. Inner corner of outer branch of hamule medially angled, forming a point (Figure 11b, j, o–p, r, t–u) 15
12. Abdomen slightly or not constricted at base (as in Figure 7c) and wide in ventral view, with ventral terga S4–5 relatively wide and short (as in Figure 8c); Colombia, Venezuela, Surinam, French Guiana, Brazil, Bolivia, Ecuador, and NE Argentina (Figure 23) *O. ambirufa*
- 12'. Abdomen narrowing abruptly at base (Figure 4d, 19e–f, i–j) and slender in ventral view, with ventral terga S4–5 relatively narrow and long (as in Figure 8e, g) 13
13. Dorsum of S1–7 orange to red, S8–10 mostly black; Mexico to Venezuela and Colombia (Figure 20) *O. levis*
- 13'. Dorsum of S1–3 orange or reddish brown, S4–10 mostly black with narrow orange to yellow medial longitudinal stripes and sometimes ventrolateral stripes (Figure 19e–f, i) 14
14. Frons bright metallic purple; mesepisternum with well defined yellow stripes (Figure 19f), although thoracic markings might be obscured in mature males (Figure 19e); Colombia, Venezuela, Trinidad, Guyana, Surinam, Brazil, Peru, and Bolivia (Figure 24) *O. attenuata*
- 14'. Frons red to reddish brown; mesepisternum with ill-defined yellow areas (Figure 19g); Trinidad, Venezuela, Guyanas, and Brazil (Figure 24) *O. concolor*
15. Outer surface of outer branch of hamule grooved (Figure 11t, u) 16
- 15'. Outer surface of outer branch of hamule not grooved (Figure 11b, j, o, p, r) 17
16. Hamule inner and outer branches forming an acute angle between them (Figure 11t); vesica spermalis distal segment with basal sclerotized portion much longer than its maximum width (Figure 13s) and distal portion with membranous outer lobe ca. as long as basal sclerotized portion, and medioectal sclerotized lobe ca. half as long as outer membranous lobe (Figure 12s); SE Peru and Bolivia (Figure 22) *O. tambopatae*
- 16'. Hamule inner and outer branches forming a rounded open curve between them (Figure 11u); vesica spermalis distal segment with basal sclerotized portion as long as its maximum width (Figure 13t) and distal portion with membranous outer lobe shorter than basal sclerotized portion, and medioectal sclerotized lobe ca. as long as outer membranous lobe (Figure 12t); Bolivia (Figure 22) *O. teres*
17. Outer branch of hamule bent ventrally over inner branch (Figure 11j, r) 18
- 17'. Outer branch of hamule ending at about same plane as inner branch (Figure 11o, p) 19

18. Pterothorax dark reddish brown to black with yellow stripes in young adults (Figure 2k), to progressively obscured, with pterothorax entirely dark in mature males; Pt dark reddish brown to black; inner and outer branches of hamule separated by a distance longer than length of inner branch (Figure 11j); Costa Rica south to NE Argentina (Figure 21) *O. cultriformis*
- 18'. Pterothorax marbled (Figure 2v); Pt pale orange; inner and outer branches of hamule separated by a distance shorter than length of inner branch (Figure 11r); Chaco forest of Argentina and Paraguay (Figure 22) *O. philipi*
19. Dorsum of S4–7 mostly red (Figure 5a); SE Brazil, Argentina, and Uruguay (Figure 22) *O. ambinigra*
- 19'. Dorsum of S4–7 dark with medial longitudinal and ventrolateral yellow or orange stripes (Figures 4g–h, 19 m) 20
20. Vesica spermalis distal segment with a strong sclerotized lateral spine on medioectal distal lobe (Figure 12m); Panama (Figure 20) *O. garrisoni*
- 20'. Vesica spermalis distal segment with a sclerotized ridge covered with minute spines on medioectal distal lobe (Figure 12l); Venezuela, Brazil, and Bolivia (Figure 23) *O. flavopicta*

Key to females of *Orthemis*

Females of *O. celata*, *O. philipi*, *O. tambopatae*, and *O. teres* are still unknown. An isolated female of *O. harpago* is here tentatively identified as this species by supposition and included in the key. Comparison of unknown material to description, diagnosis, and figures under the particular account for the species reached in the key is advised before considering identification as final.

1. Wings with extensive dark markings along C-RA space; larger species (Hw > 50 mm); Venezuela, Surinam, Brazil, Ecuador, and Peru (Figure 21) *O. regalis*
- 1'. Wings lacking extensive dark markings along C-RA space; smaller species (Hw < 45 mm) 2
2. S4 apical width/length 0.59 or more and 4 rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (as in Figure 3a) *ferruginea* group 3
- 2'. S4 apical width/length 0.57 or less and 2–3 rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (as in Figure 3b) *levis* group 4
3. Rim of vulvar lamina with a deep medial inverted U-shaped excision and paired depressions under convex lateral margins (Figure 18r); Ecuador and Peru (Figure 21) *O. paulsoni*
- 3'. Rim of vulvar lamina lacking a deep medial inverted U-shaped excision, either ca. straight, shallowly concave, or slightly trilobate (Figure 18f, q, t) other species in *ferruginea* group (for diagnoses see De Marmels, 1988; Donnelly, 2001; Meurgey & Daigle, 2007; Paulson, 2001; Ris, 1910)
4. Vulvar lamina consisting of posterior margin of sternum of S8 forming an inverted U-shaped rim (Figure 18d–e, i, p) 5
- 4'. Vulvar lamina consisting of transverse and/or longitudinal rims anterior to posterior margin of sternum of S8 (Figure 18a–c, g–h, j–o) 8
5. Medial excision of vulvar lamina wider than its lateral margins (Figure 18d); abdomen wide and only slightly and gradually narrowed at base (Figures 7c, 8c); Colombia, Venezuela, Surinam, French Guiana, Brazil, Bolivia, Ecuador, and NE Argentina (Figure 23) *O. ambirufa*
- 5'. Medial excision of vulvar lamina narrower than its lateral margins (Figure 18e, i, p); abdomen slender, abruptly narrowed at base (Figures 7e, g, m, 8e, g) 6

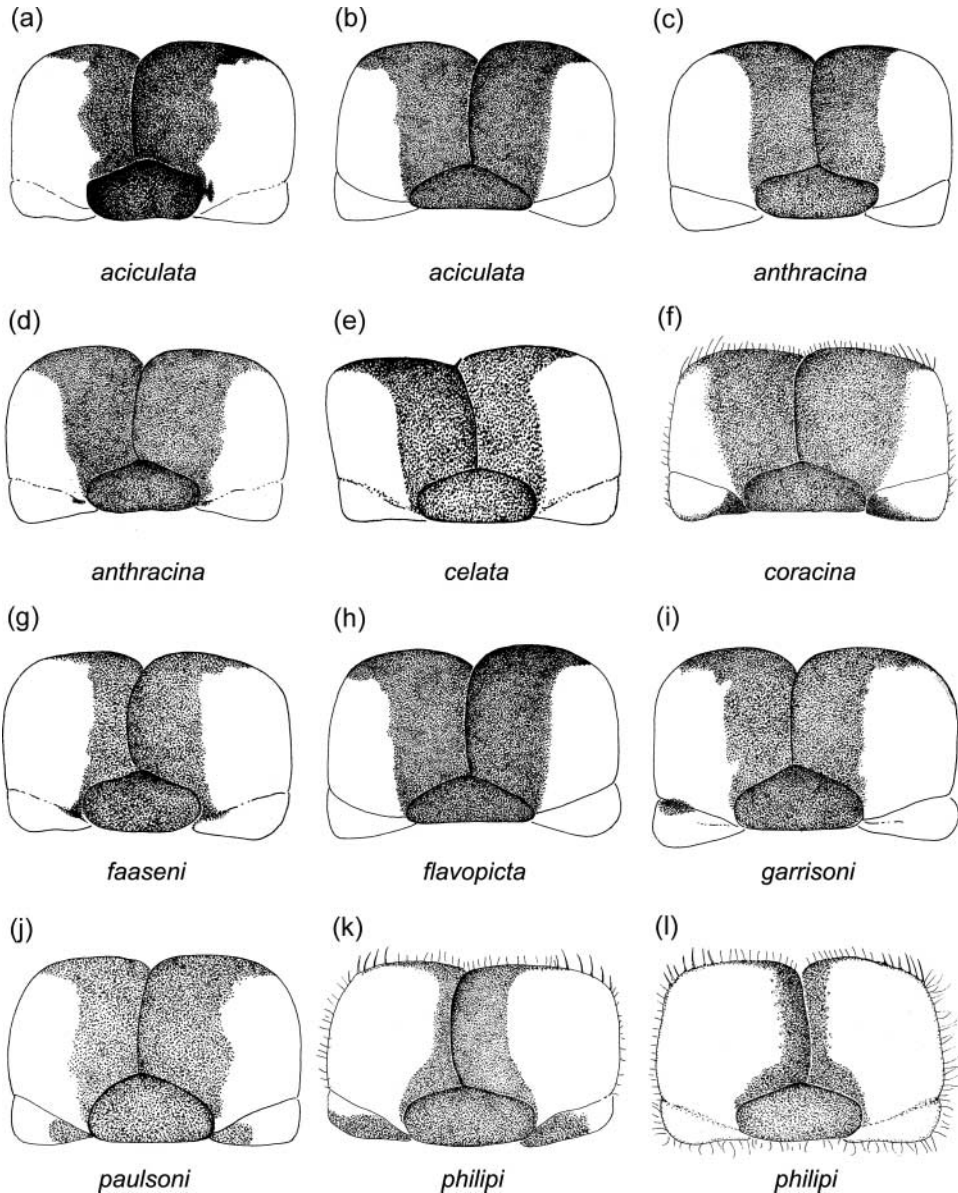


Figure 1. Prementum and labial palps, ventral view – (a) *Orthemis aciculata*, paratype female, Surinam, Pontijbrug; (b) *O. aciculata*, paratype female, paralectotype of *O. flavopicta*, Brazil, “Pará”; (c) *O. anthracina*, male, Peru, Tamshiyacu; (d) *O. anthracina*, female, Peru, Tamshiyacu; (e) *O. celata*, holotype male; (f) *O. coracina*, holotype male; (g) *O. faaseni*, paratype male; (h) *O. flavopicta*, lectotype male; (i) *O. garrisoni*, holotype male; (j) *O. paulsoni*, holotype male; (k) *O. philipi*, holotype male; (l) *O. philipi*, paratype male, E of Las Varas.

6. Mesepisternum with ill-defined diffuse yellow stripes or areas (Figure 19h); paired depressions anterior to vulvar lamina rim confined to sides along lateral margins of medial excision of rim (Figure 18i); Trinidad, Venezuela, Guyanas, and Brazil (Figure 24) *O. concolor*
- 6'. Mesepisternum with well-defined yellow stripes (as in Figure 19f); paired depressions anterior to vulvar lamina rim located anterior to lateral margins of medial excision of rim (Figure 18e, p) 7

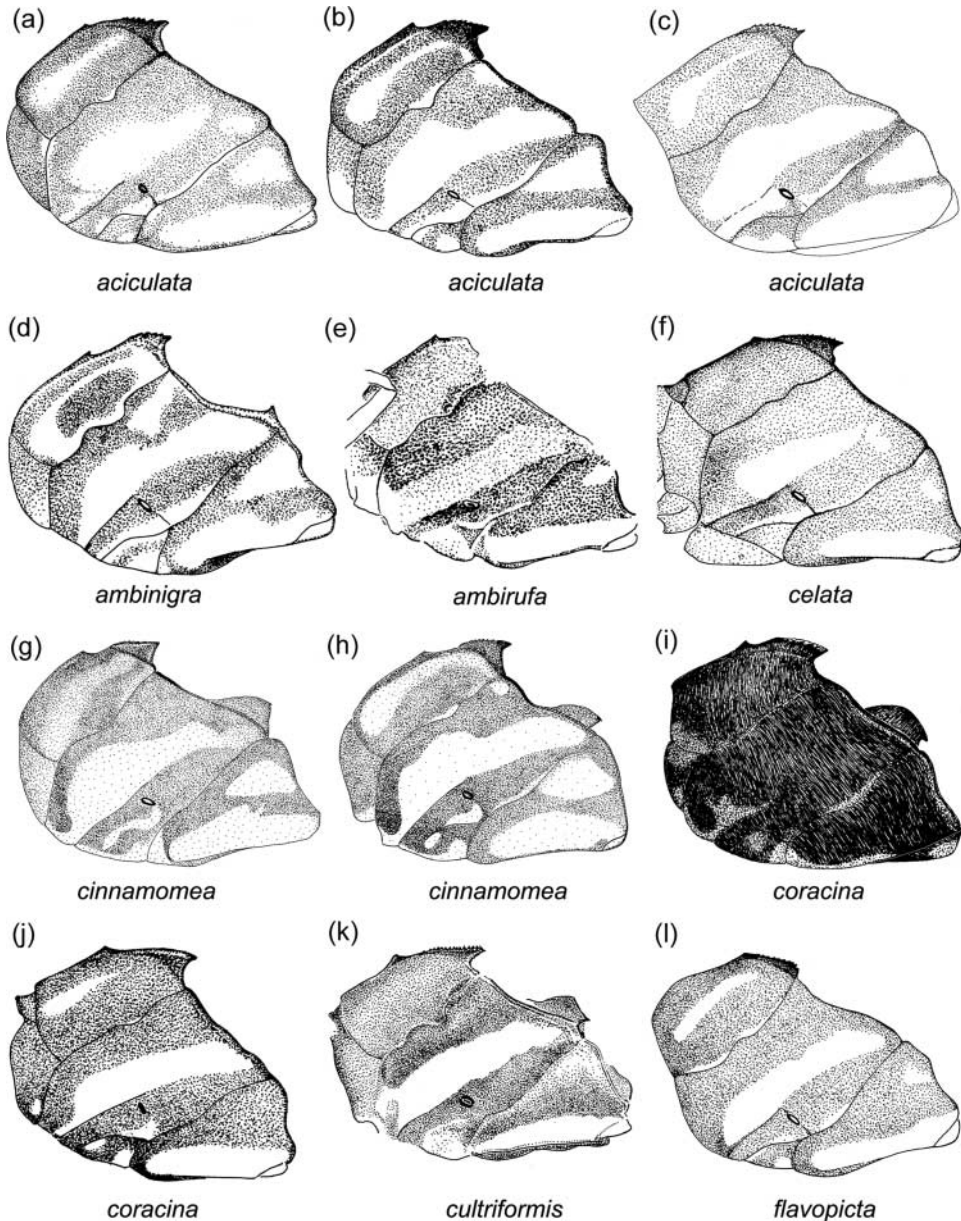


Figure 2. Pterothorax, (a–l) lateral view – (a) *Orthemis aciculata*, holotype male; (b) *O. aciculata*, paratype female, Surinam, Pontijbrug; (c) *O. aciculata*, paratype female, paralectotype of *O. flavopicta*, Brazil, “Pará”; (d) *O. ambinigra*, female, Brazil, Porto Alegre; (e) *O. ambirufa*, holotype; (f) *O. celata*, holotype male; (g) *O. cinnamomea*, holotype male; (h) *O. cinnamomea*, paratype female, Peru, Explorer’s Inn; (i) *O. coracina*, holotype male; (j) *O. coracina*, female, Surinam, Sipaliwini; (k) *O. cultriformis*, lectotype male; (l) *O. flavopicta*, lectotype male. Figure 2e by RWG.

7. Abdomen base between apex of S2 and base of S3 markedly globose (Figure 7e); dorsal terga S4–7 mostly dark reddish brown to black with narrow mediodorsal and ventrolateral pale stripes; Colombia, Venezuela, Trinidad, Guyana, Surinam, Brazil, Peru, and Bolivia (Figure 24).....*O. attenuata*

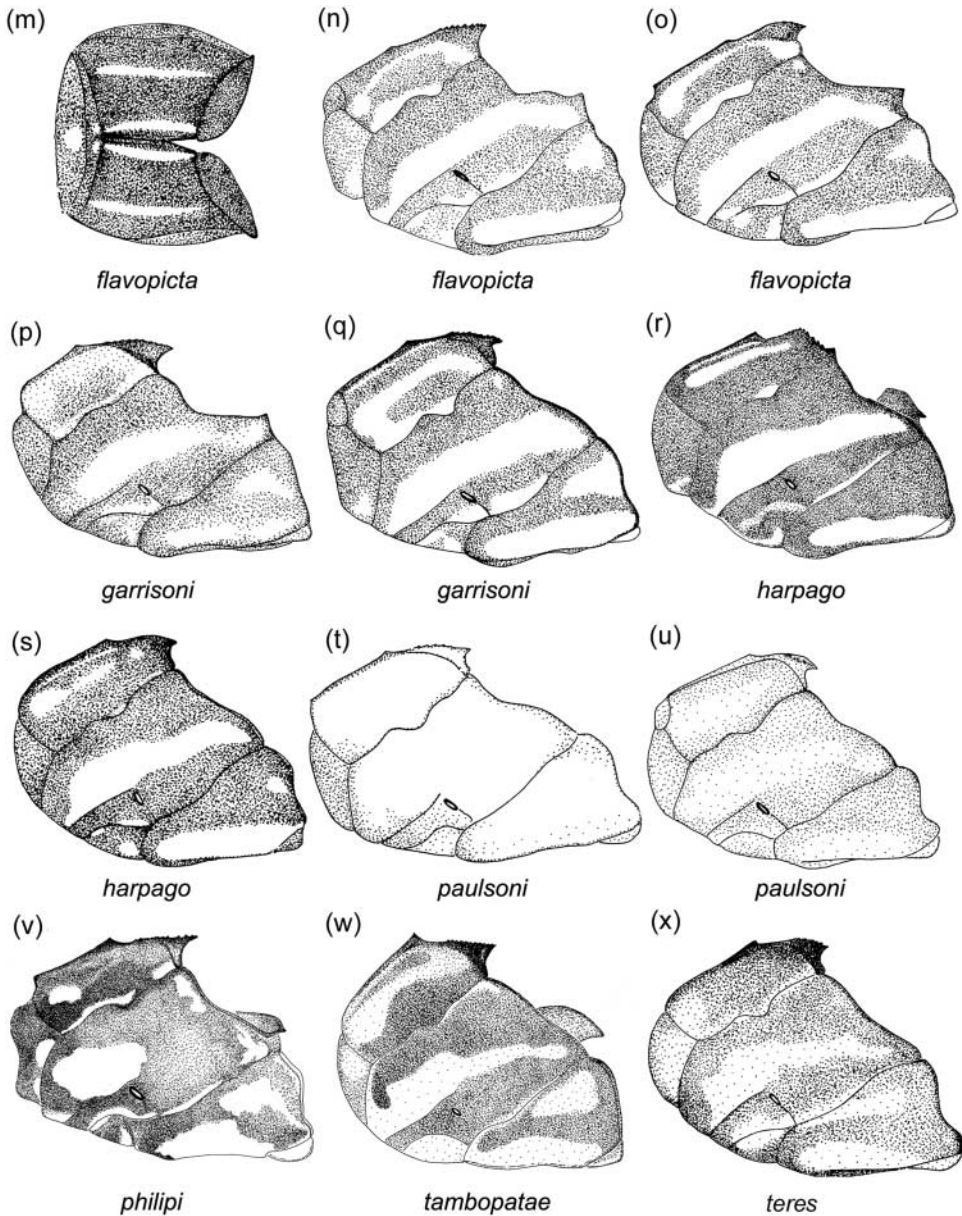


Figure 2. Continued. (m) dorsal view, *Orthemis flavopicta*, paralectotype male. Pterothorax, (n–x) lateral view – (n) *O. flavopicta*, male, Brazil, Cacauplandia; (o) *O. flavopicta*, female, Brazil, Lauro de Freitas; (p) *O. garrisoni*, holotype male; (q) *O. garrisoni*, paratype female; (r) *O. harpago*, holotype male; (s) *O. harpago*, female, Peru, Aguas Negras; (t) *O. paulsoni*, holotype male; (u) *O. paulsoni*, paratype female; (v) *O. philipi*, paratype male; (w) *O. tambopatae*, holotype male; (x) *O. teres*, holotype male.

- 7'. Abdomen base between apex of S2 and base of S3 not markedly globose (Figure 7m); dorsal terga S4–7 with some red color between mediodorsal and ventrolateral pale stripes, sometimes obscured in preserved specimens; Mexico to Venezuela and Colombia (Figure 20)
..... *O. levis*

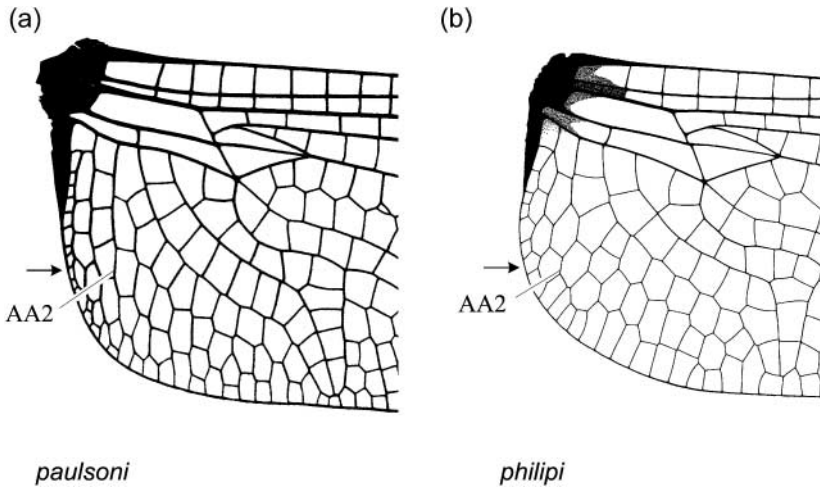


Figure 3. Hw base, lateral view – (a) *Orthemis paulsoni*, paratype male, Ecuador, Shushufindi; (b) *O. philipi*, paratype male, Argentina, E of Puerto Varas. Arrow indicates level of anal loop heel.

8. Vulvar lamina consisting of an inverted U-shaped ridge located slightly anterior to posterior margin of S8, separated from posterior margin by its own length or less (Figure 18c, m–n) 9
- 8'. Vulvar lamina consisting of a medial longitudinal ridge and a transverse ridge distinctly anterior to posterior margin of S8, separated from posterior margin by twice its own length or more, both usually enclosed by anterolateral semicircular ribs (Figure 18a–b, g–h, j–l, o)..... 11
9. Vulvar lamina consisting of a thin laminar ridge (Figure 18c; slanted posteromedially); labial palp with medial 0.50 or more black; SE Brazil, Argentina, and Uruguay (Figure 22) *O. ambinigra*
- 9'. Vulvar lamina consisting of a swollen ridge, rounded in cross-section (Figure 18m–n); labial palp with medial 0.40 or less black 10
10. Transverse bar of U-shaped ridge of vulvar lamina as long as longitudinal arms of ridge (Figure 18n); Panama (Figure 20) *O. garrisoni*
- 10'. Transverse bar of U-shaped ridge of vulvar lamina shorter than longitudinal arms of ridge (Figure 18m); Venezuela, Brazil, and Bolivia (Figure 23) *O. flavopicta*
11. Transverse anterior ridge of vulvar lamina with triangular projections (Figure 18g–h, j, l, o) 12
- 11'. Transverse anterior ridge of vulvar lamina lacking triangular projections (Figure 18a–b, k) 16
12. Triangular projections of transverse anterior ridge of vulvar lamina directed laterally (Figure 18g); Venezuela, Trinidad, Surinam, Colombia, and N Peru (Figure 25) *O. anthracina*
- 12'. Triangular projections of transverse anterior ridge of vulvar lamina directed anterolaterally (Figure 18h, j, l, o) 13
13. Triangular projections of transverse anterior ridge of vulvar lamina concave ventrally (Figure 18j, o) 14
- 13'. Triangular projections of transverse anterior ridge of vulvar lamina convex ventrally (Figure 18h, l) 15

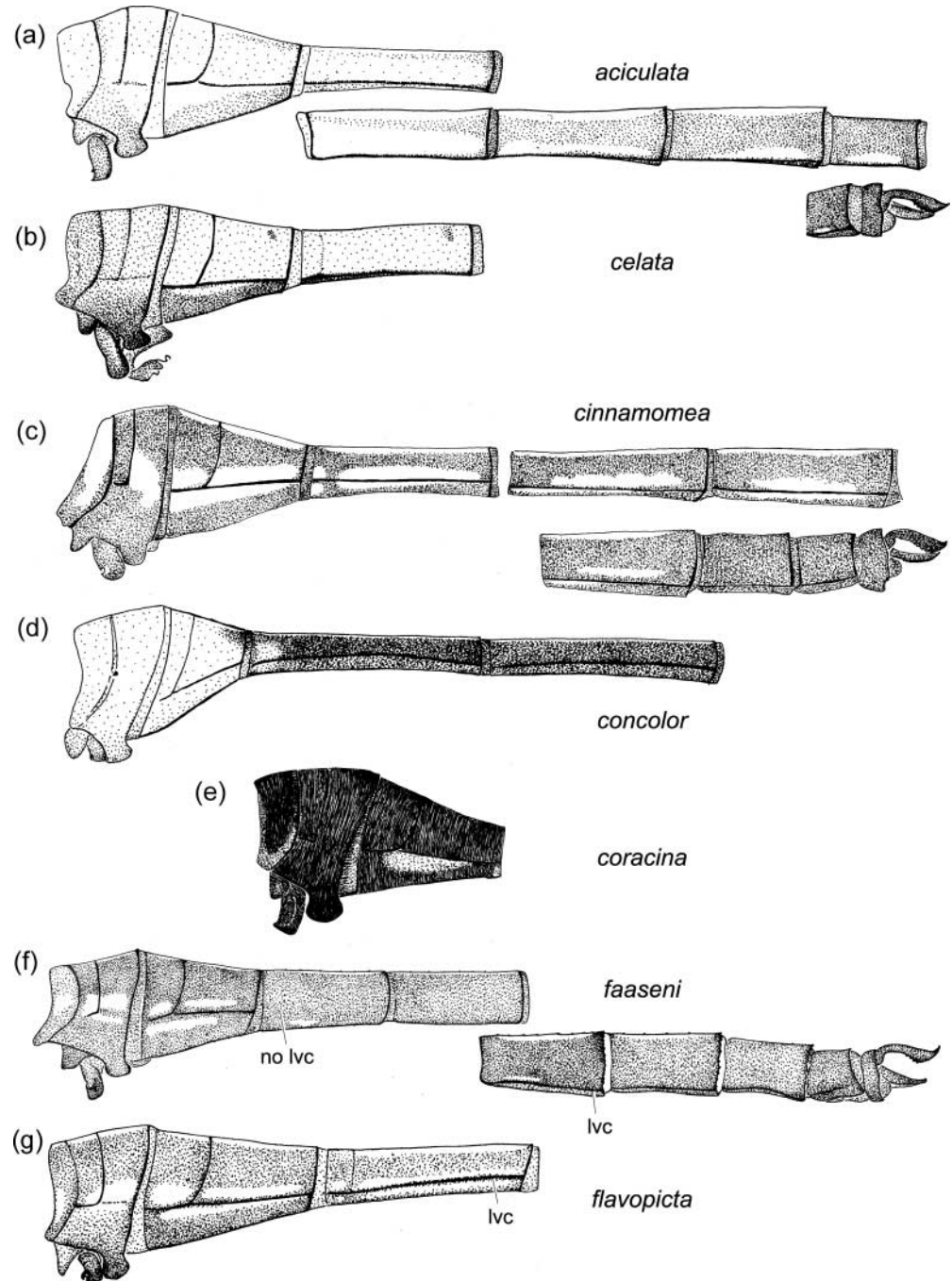


Figure 4. Male abdomen, lateral view – (a) *Orthemis aciculata*, holotype; (b) *O. celata*, holotype; (c) *O. cinnamomea*, holotype; (d) *O. concolor*, lectotype; (e) *O. coracina*, holotype; (f) *O. faaseni*, paratype; (g) *O. flavopicta*, lectotype. Abbreviation: lvc: latero-ventral carina.

14. Abdomen narrowing gradually at base, with base of S4 more than half as high as base of S3 in lateral view (Figure 7h); transverse end of vulvar lamina more anterior, separated from posterior margin of S8 by more than its width (Figure 18j); Surinam, Colombia, Ecuador, N Peru, and Brazil (Figure 25) *O. coracina*

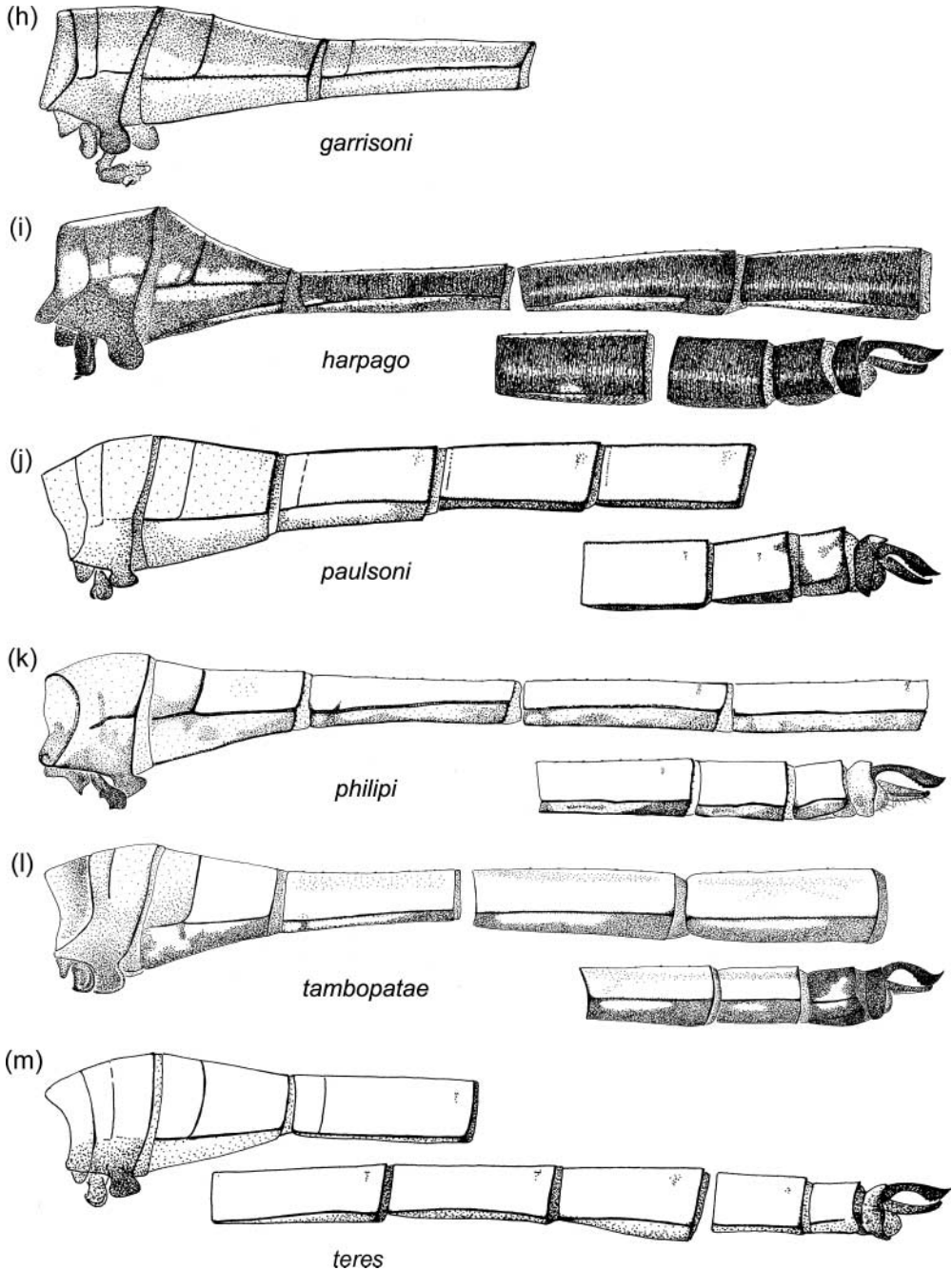


Figure 4. Continued. (h) *O. garrisoni*, holotype; (i) *O. harpago*, holotype; (j) *O. paulsoni*, holotype; (k) *O. philipi*, holotype; (l) *O. tambopatae*, holotype; (m) *O. teres*, holotype.

14'. Abdomen narrowing abruptly at base, with base of S4 less than half as high as base of S3 in lateral view (Figure 71); transverse end of vulvar lamina more posterior, separated from posterior margin of S8 by a distance ca. equal to its width (Figure 18o); Peru and Brazil (Figure 22).....*O. harpago*

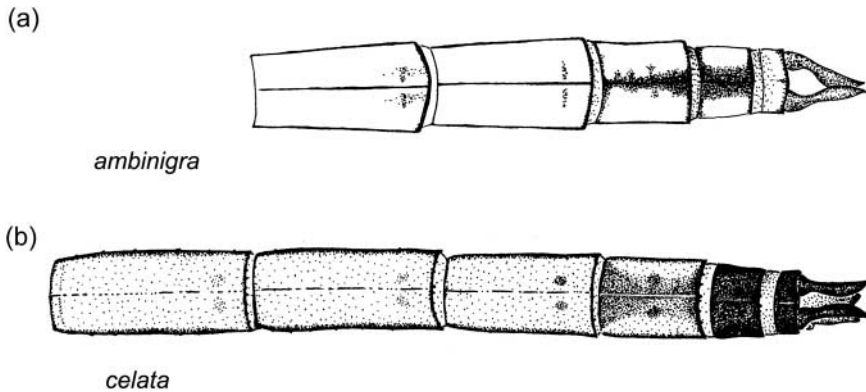


Figure 5. Male abdomen, dorsal view – (a) *Orthemis ambinigra*, holotype of *O. plaumanni*; (b) *O. celata*, holotype.

15. Abdomen narrowing abruptly at base, with base of S4 less than half as high as base of S3 in lateral view (Figure 7f); S4 length 5.2–5.7 mm; S4 apical width/length 0.30–0.39; S8 flap whitish (Figure 19b); Ecuador and Peru (Figure 23) *O. cinnamomea*
- 15'. Abdomen narrowing gradually at base, with base of S4 more than half as high as base of S3 in lateral view (Figure 7i); S4 shorter and wider: S4 length 4.3 mm; S4 apical width/length 0.53; S8 flap reddish brown (Figure 19l); N Peru and W Brazil (Figure 20) *O. faaseni*
16. Lateral ends of anterior transverse ridge of vulvar lamina barely projected posteriorly (Figure 18a–b); Panama, Trinidad, Surinam, N Brazil, and N Peru (Figure 25) *O. aciculata*
- 16'. Lateral ends of anterior transverse ridge of vulvar lamina considerably projected posteriorly, almost reaching posterior margin of S8, giving the ridge the shape of an M (Figure 18k); Costa Rica south to NE Argentina (Figure 21) *O. cultriformis*

Species accounts

Orthemis aciculata sp. nov.

Figures 1a–b, 2a–c, 4a, 5, 6a, 7a, 8a, 9a, 10a, 11a, 12a, 13a, 14a, 15a, 16a, 17a, 18a–b, 19a, 25

Orthemis anthracina nec De Marmels, 1989 – von Ellenrieder (2009, pp. 349, 374, 379, figures 8c, 9c, 14c, 15c, 21, table 1; illustrations of hamule, map, inclusion in key; misidentification of a male from Panama).

Orthemis cultriformis nec Calvert, 1899 – von Ellenrieder (2009, pp. 349, 372, 373, figures 16f, 18d; misidentification of a female from Trinidad).

Orthemis flavopicta nec Kirby, 1889 – Kirby (1889: in part, misidentification of female); Belle (2002, p. 5, record from Surinam; misidentification).

Etymology

This species is named *aciculata* (from the Latin noun *acicula* meaning splinter) in reference to the splinter-shaped sclerotized projection on medioectal lobe of distal segment of vesica spermalis.

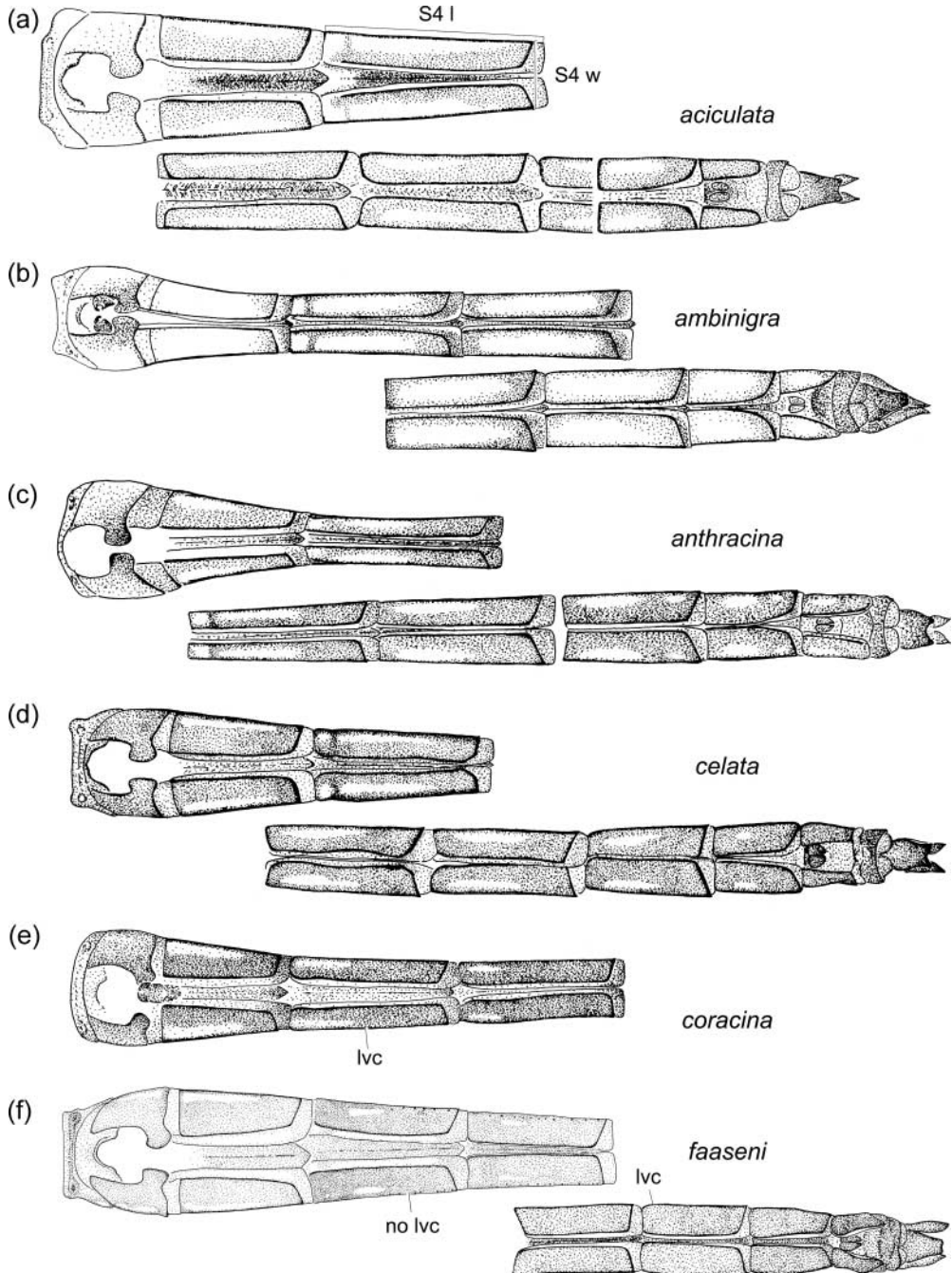


Figure 6. Male abdomen, ventral view – (a) *Orthemis aciculata*, holotype; (b) *O. ambinigra* holotype of *O. plaumanni*; (c) *O. anthracina*, Peru, Tamshiyacu, in copula; (d) *O. celata*, holotype; (e) *O. coracina*, holotype; (f) *O. faaseni*, paratype. Abbreviations: lvc: lateroventral carina; S4 I: S4 length; S4 w: S4 apical width.

Type specimens examined

Total 14 ♂, 8 ♀. – Holotype ♂: Surinam, Para Dist., road near forest, Zanderij I (5°32' N, 55°10' W), 17 January 1957, leg. J. Belle [RMNH]; paratypes: 1 ♂, Panama, Panamá Prov., trail at

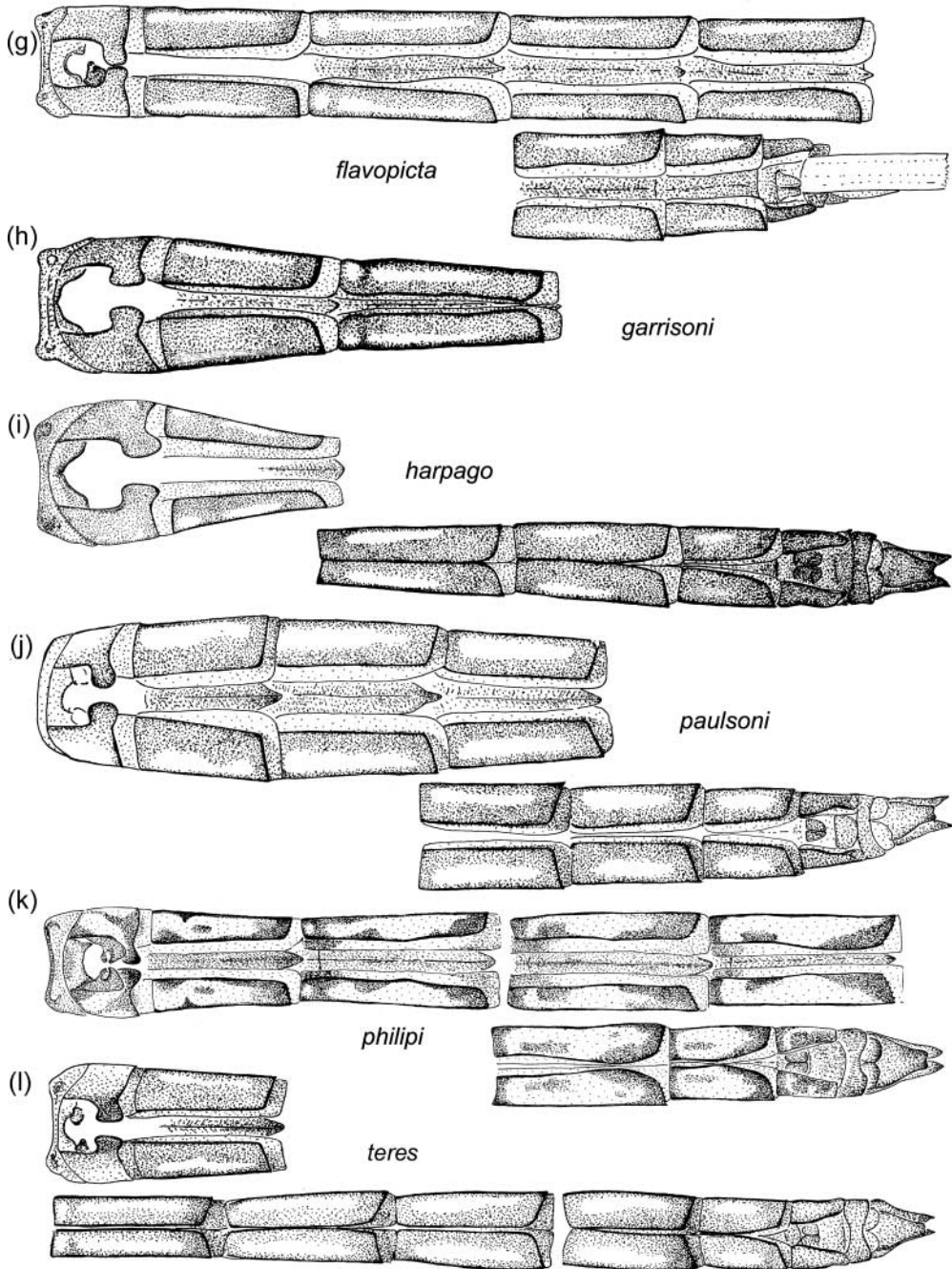


Figure 6. Continued. (g) *Orthemis flavopicta*, lectotype; (h) *Orthemis garrisoni*, holotype; (i) *O. harpago*, holotype; (j) *O. paulsoni*, holotype; (k) *O. philipi*, holotype; (l) *O. teres*, holotype.

milepost 12, by Gaillard highway, 7.4 km SE of Gamboa (9°4'0" N, 79°40'0" W), 3 August 1979, leg. J.A. Garrison & RWG [RWG]; 1 ♂, Trinidad, St. George Parish, Arima river tributary, 3 mi S of Arima (10°43' N, 61°17' W, 480 m), 13 April 1966, leg. T.W. Donnelly [TWD]; 1 ♂, same but 15 April 1965 [TWD]; 1 ♀ Trinidad, Nariva, pond between Río Claro & Navet, W side of Cunapo southern road (10°20'17" N, 61°11'30" W), 3 May 1988, leg. S.W. Dunkle [FSCA]; 1 ♂,

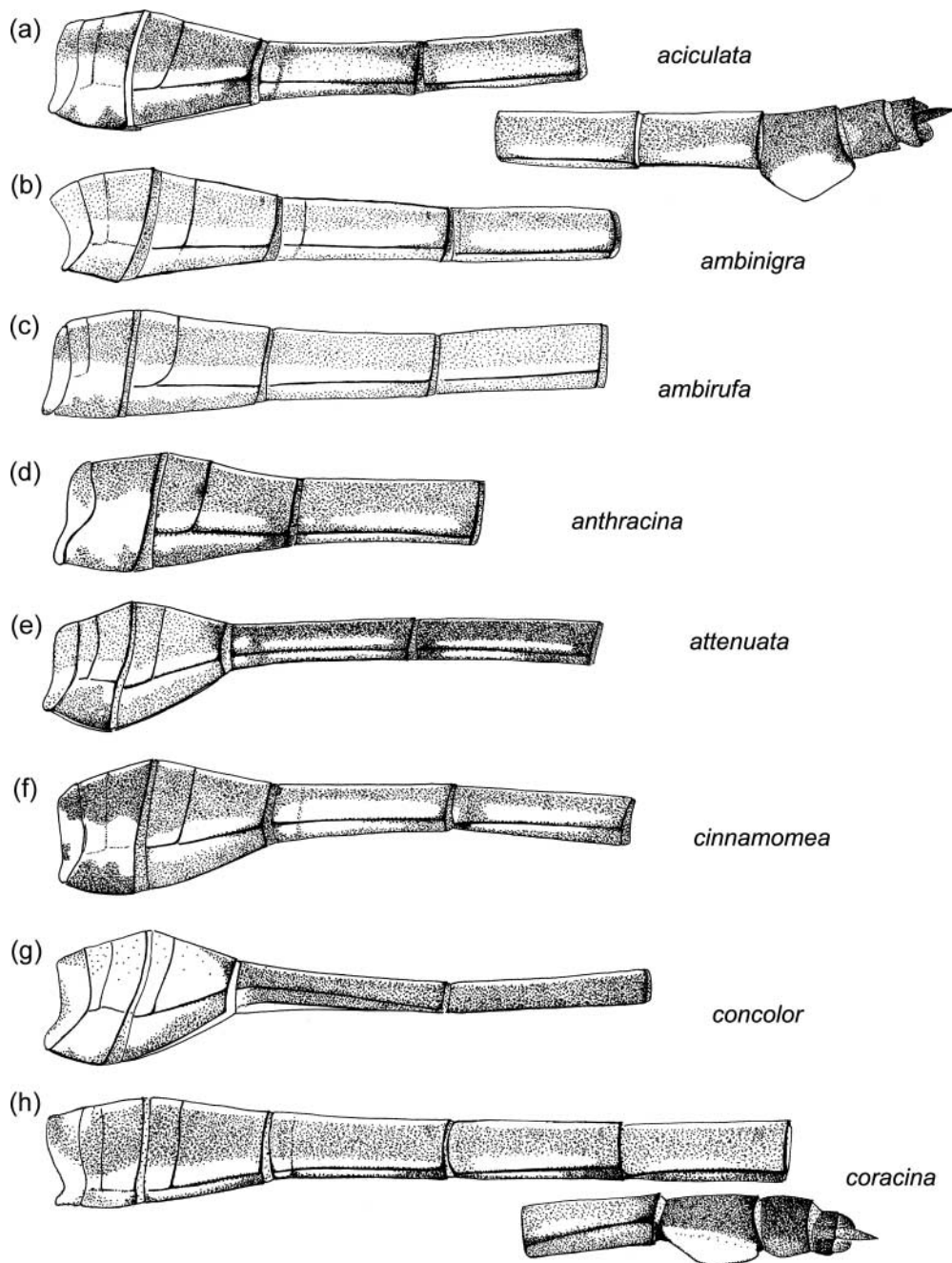


Figure 7. Female abdomen, lateral view – (a) *Orthemis aciculata*, paratype, Surinam, Pontijbrug; (b) *O. ambinigra*, Brazil, Porto Alegre; (c) *O. ambirufa*, Bolivia, Beni; (d) *O. anthracina*, Peru, Tamshiyacu; (e) *O. attenuata*, Colombia, Puerto Berrio; (f) *O. cinnamomea*, Peru, Tamshiyacu; (g) *O. concolor*, Trinidad, Aripo; (h) *O. coracina*, Brazil, Rio Gurupí.

1 ♀ Trinidad, St. Andrew, Aripo Savanna (10°36' N, 61°12' W), 4 May 1988, leg. S.W. Dunkle [FSCA]; 1 ♀ same but [RWG]; 1 ♂, 1 ♀, same but swamp 3 km S of Valencia on Eastern Main road (10°37'26" N, 61°10'55" W), 2 May 1988 [FSCA]; 1 ♂, same as holotype but [RMNH];

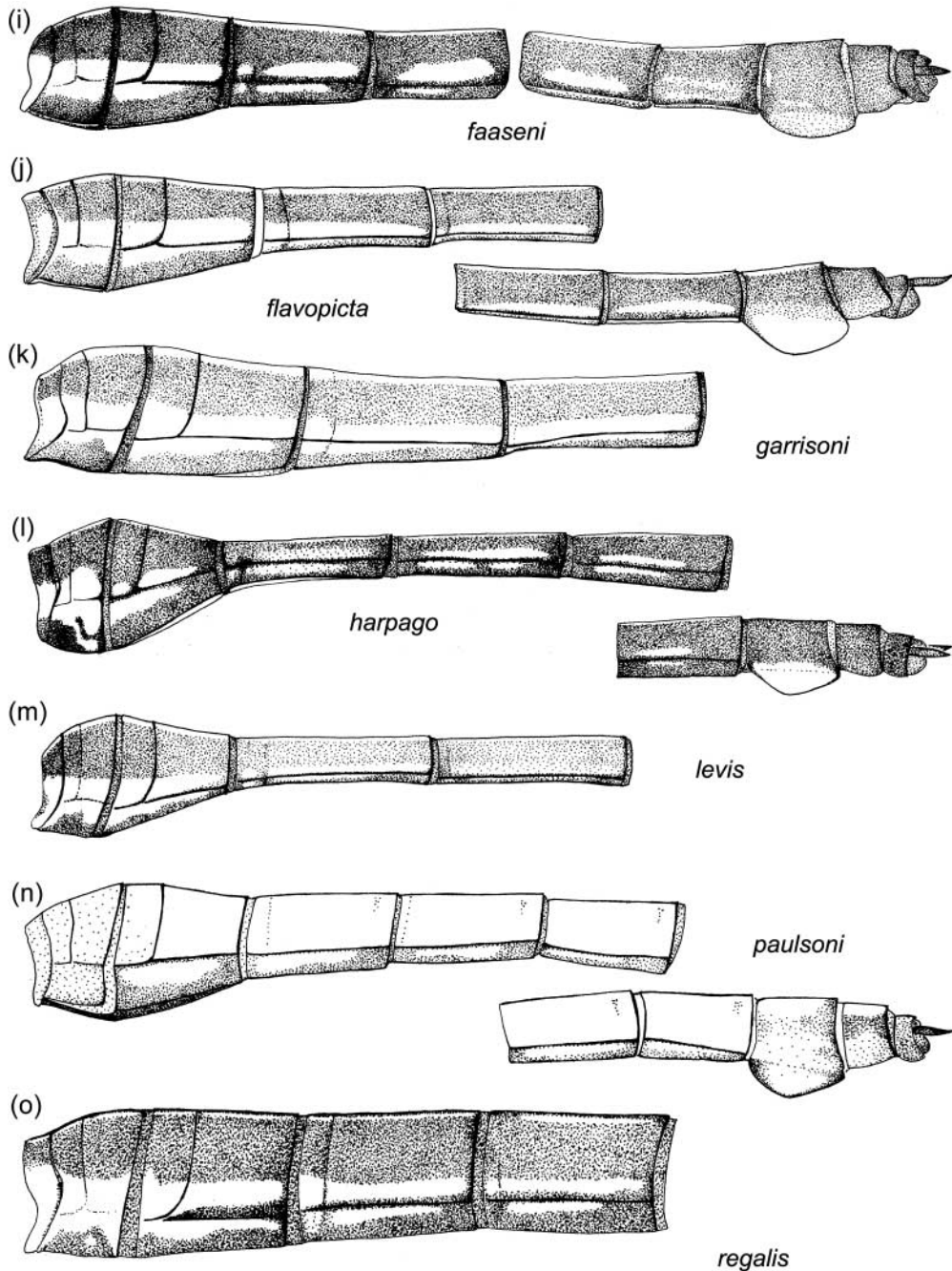


Figure 7. Continued. (i) *O. faaseni*, paratype, Peru, Tamshiyacu; (j) *O. flavopicta*, Brazil, Lauro de Freitas; (k) *O. garrisoni*, paratype, Panama, Corozal; (l) *O. harpago*, Peru, Aguas Negras; (m) *O. levis*, paratype, Guatemala, Escuintla; (n) *O. paulsoni*, paratype, Peru, Tambopata; (o) *O. regalis*, Surinam, Brownsweeg.

1 ♂, same but Pontijbrug, 17 March 1957 [RMNH]; 1 ♂, same but 11 April 1957 [RMNH]; 1 ♂, same but 14 October 1956 [RMNH]; 2 ♂, Surinam, Para Dist., Mapane, bosweg kamp 8–12 (5°28' N, 54°41' W), 8/10 December 1953, leg. D.C. Geijskes [RMNH]; 1 ♀, Surinam, Para

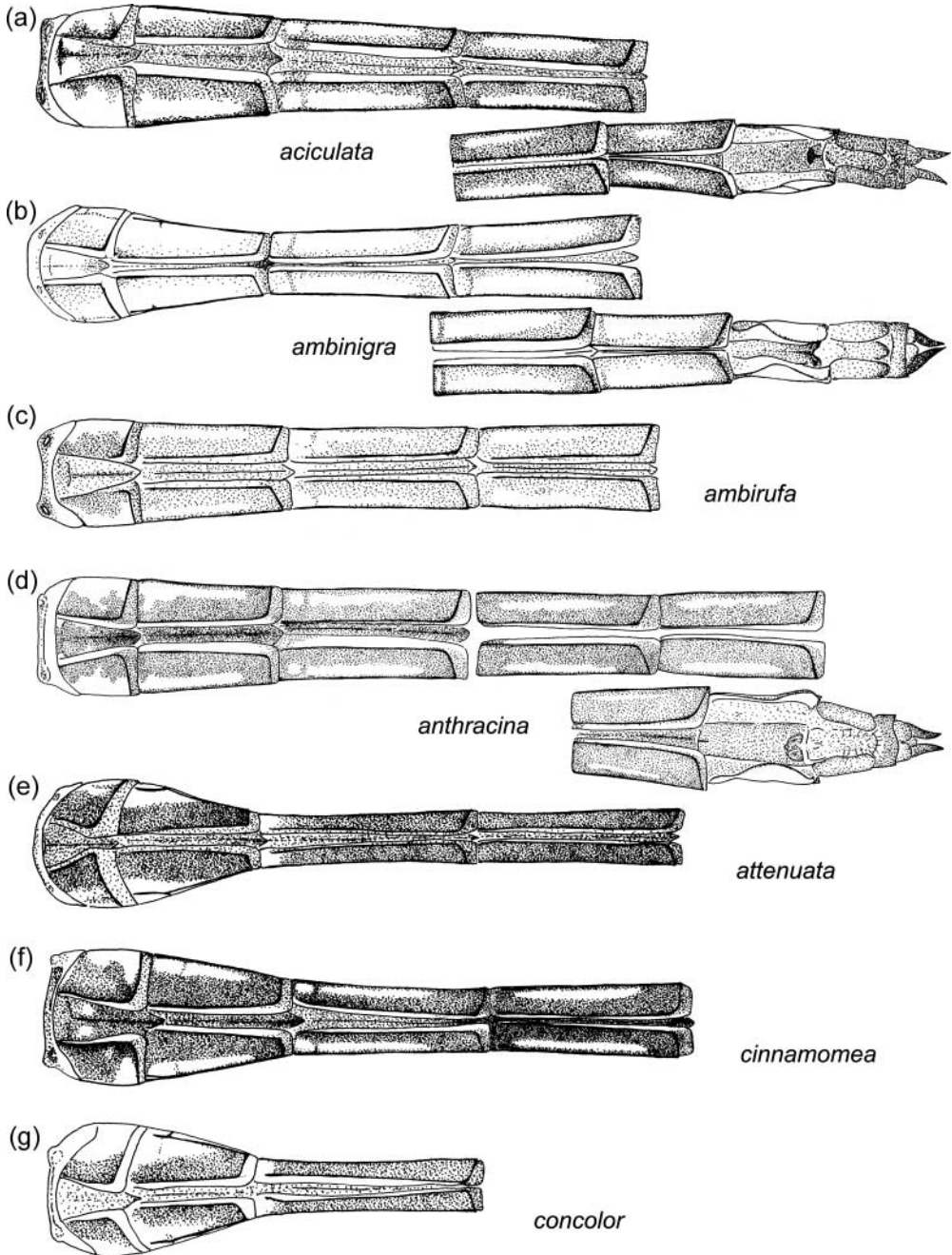


Figure 8. Female abdomen, ventral view – (a) *Orthemis aciculata*, paratype, Surinam, Pontijbrug; (b) *O. ambinigra* Brazil, Porto Alegre; (c) *O. ambirufa*, Bolivia, Beni; (d) *O. anthracina*, Peru, Tamshiyacu; (e) *O. attenuata*, Colombia, Fundación; (f) *O. cinnamomea*, Peru, Tamshiyacu; (g) *O. concolor*, Trinidad, Aripo.

Dist., Dauwdrup, Zanderij I (5°32' N, 55°10' W), 17 January 1957, leg. J. Belle [RMNH]; 1 ♀, same but Pontijbrug, 21 May 1957 [RMNH]; 1 ♀, same but 24 January 1957 [RMNH]; 1 ♀, Brazil, “Pará”, Paralectotype of *O. flavopicta* Kirby, 1889 [BMNH]; 1 ♂, Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, Río Tahuayo, black water river near lodge (4°23'19" S, 73°15'26" W), 11 August 2009, leg. TF [TF].

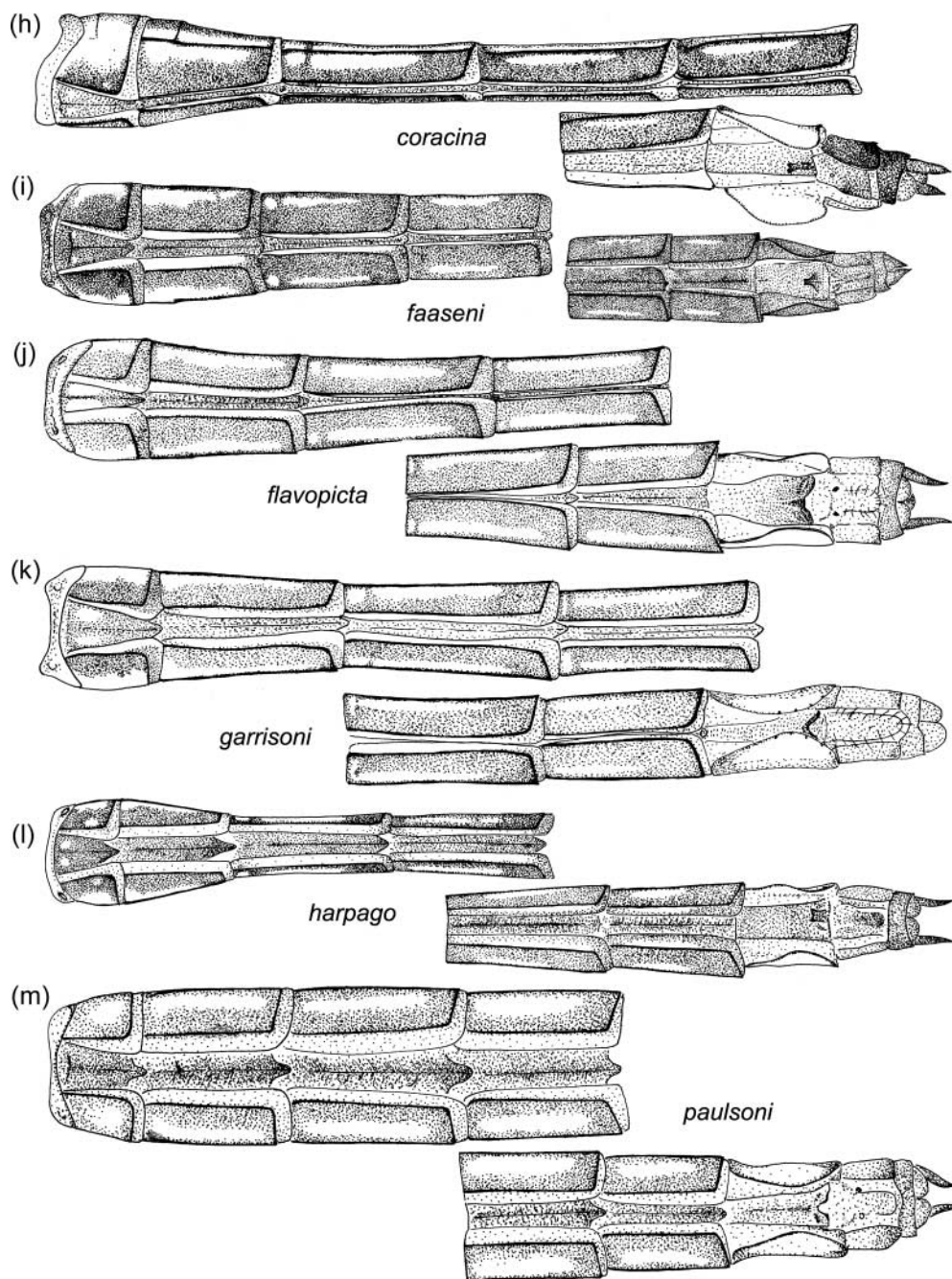


Figure 8. Continued. (h) *O. coracina*, Brazil, Rio Gurupí; (i) *O. faaseni*, paratype, Peru, Tamshiyacu; (j) *O. flavopicta*, Brazil, Lauro de Freitas; (k) *O. garrisoni*, paratype, Panama, Corozal; (l) *O. harpago*, Peru, Aguas Negras; (m) *O. paulsoni*, paratype, Peru, Tambopata.

Male holotype

Head. Prementum black; labial palps pale yellow with medial black stripe as wide as about 0.40 of palp width and anterior margin narrowly black (as in Figure 1b); labrum black with

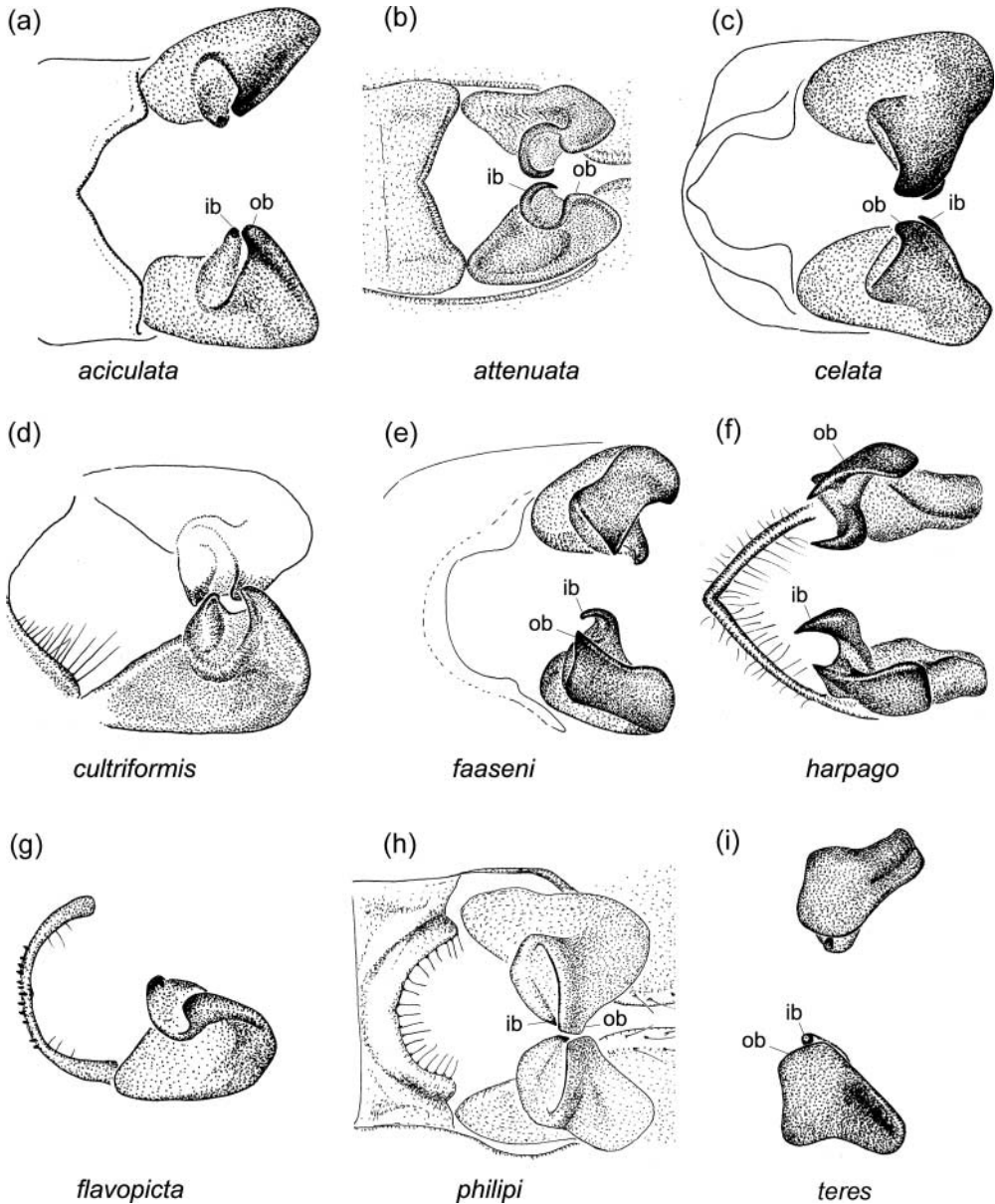


Figure 9. Male posterior hamule, ventral view (to scale) – (a) *Orthemis aciculata*, holotype; (b) *O. attenuata*, Brazil, Cacaullandia; (c) *O. celata*, holotype; (d) *O. cultriformis*, lectotype; (e) *O. faaseni*, paratype; (f) *O. harpago*, holotype; (g) *O. flavopicta*, lectotype; (h) *O. philipi*, paratype; (i) *O. teres*, holotype. Abbreviations: ib: inner branch; ob: outer branch. Figure 9d by RWG.

mediobasal reddish spot; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, remainder of anteclypeus pale reddish brown, postclypeus pale reddish brown with medial dark brown spot and postclypeal lobes narrowly fringed with a dark brown line along distal margin; ventral half of antefrons reddish brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex metallic purple with blue reflections, occipital triangle red to reddish brown posteriorly, rear of head orange to reddish brown around occipital triangle and

yellow along eyes. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown except anterior lobe margined with pale yellow. Pterothorax reddish brown with pale yellow stripes as follows (Figure 2a): narrow diffuse stripe lateral to mediodorsal carina, wider diffuse stripe at mid width, small spot at mesepisternal–mesepimeral suture ventral kink; mesepimeron with wide stripe along posterior half narrowing dorsally; metepisternum with narrow stripe along ventral margin and another sinuous one ventrally to metastigma, and oval spot on posterodorsal corner; metepimeron with stripe along posterior half, narrowing dorsally, and triangular spot on anterodorsal corner; venter of pterothorax pale yellow with triangular reddish brown spot on each side extending from base of leg and narrowing to posterior margin. – Legs with coxa, trochanter, and basal 0.50 of inner surface of pro- and mesofemur pale brown to pale yellow; femur reddish brown; tibia dark reddish brown, tarsus, pretarsus, and spines black; metafemur armed with 17 (right) to 16 (left) short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings hyaline with small amber spots at base extending to level of first row of anal cells in FW, and to level of second row and membranula distal end in HW, a very narrow reddish tinge around nodus, and distal amber spot extending from level of distal end of pterostigma to apex. One cubito-anal crossvein and arculus distal to Anx 2 in Fw and Hw; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 5 (right) to 4 (left) cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 5 rows at hind margin, Hw with 3 at base, then 2, then increasing to 13 (right) or 14 (left) at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 24 (right) to 22 (left) cells. Pt reddish brown, 4.45 (right) to 4.4 (left) long in Fw and 4.1 (right) to 4.2 (left) in Hw, overlying 4–5 cells in Fw and 4–6 cells in Hw. Anx: 16 in Fw; 13 in Hw; Pnx: 15 (right) and 14 (left) in Fw; 15 (right) and 16 (left) in Hw.

Abdomen. Sides linear, gradually narrowing from S3 to S4 in ventral view (Figure 6a), S4 about three times as long as wide (ratio apical width/length = 0.33). Dorsal terga (Figure 4a): S1–2 reddish yellow, with pale yellow mid-dorsal stripe; S3–4 red, except posterodorsal black spot extending ventrally to lateral carina on S4; S5–7 black with red mid-dorsal and ventrolateral stripes, the latter narrowing from S5 to S7; S8 black with ventrolateral stripe and mid-dorsal carina red; S9 black with small diffuse red spot at ventrobasal third; S10 and caudal appendages dark reddish brown. Ventrolateral carina on S2 vestigial, on S3–8 well developed and black, on S9 well developed along basal two thirds, absent at distal third. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 6a): S1 yellow; S2 pale yellow along ventrolateral carinae, ventrally reddish brown; S3–8 dark reddish brown with pale yellow stripe along lateral margin; S9–10 dark reddish brown. Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Figure 10a); hamule bifid with small inner branch forming short pointed spine, and larger outer branch with blunt tip bent ventrally over inner branch, separated by a distance longer than inner branch length; outer corner of outer branch smoothly rounded (Figure 11a). Distal segment of vesica spermalis with basal portion trapezoidal in ectal view (Figure 13a), and with long flagella on ental surface; distal lobes represented on each side by elongate outer oval shaped lobe longer than basal portion in lateral view, and medioectal membranous lobe with sclerotized lateral projection margined with denticles and distolateral sclerotized splinter-shaped projection (Figures 12a, 13a). Cercus markedly curved ventrally in lateral view, with row of 4–6 ventral tubercles along distal 0.50 and tip upturned (Figure 15a); in dorsal view converging along basal 0.70 with opposite cercus, then approximately parallel to it along distal 0.30 (Figure 14a). Epiproct

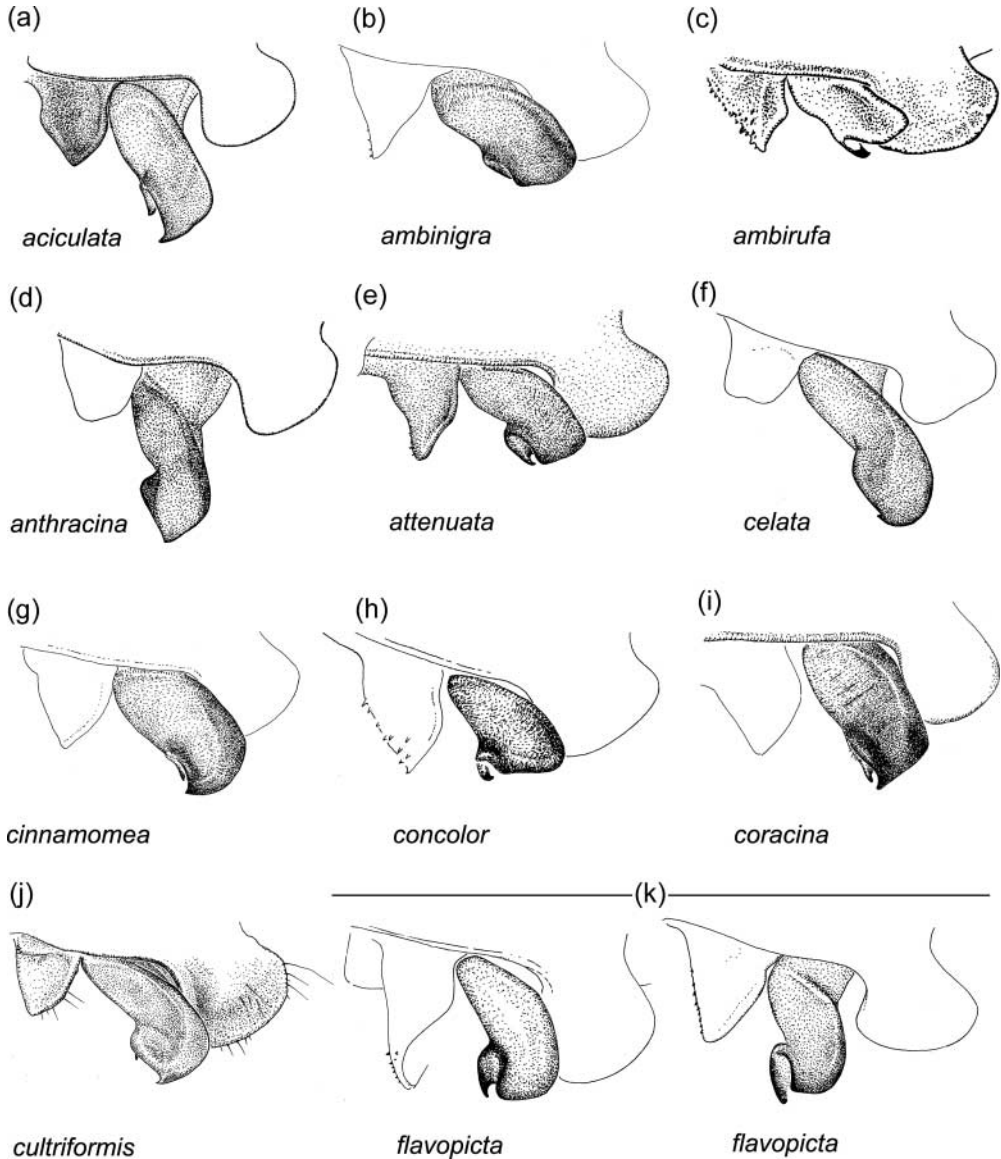


Figure 10. Male posterior hamule, lateral view (to scale)—(a) *Orthemis aciculata*, holotype; (b) *O. ambinigra*, Argentina, SE Isla de Cañas; (c) *O. ambirufa*, holotype; (d) *O. anthracina*, Peru, Tamshiyacu; (e) *O. attenuata*, Brazil, Cacauplandia; (f) *O. celata*, holotype; (g) *O. cinnamomea*, holotype; (h) *O. concolor*, French Guiana, Cacao; (i) *O. coracina*, holotype; (j) *O. cultriformis*, lectotype; (k) *O. flavopicta*, from left to right under black line: lectotype; Brazil, Cacauplandia. Figure 10c, j by RWG.

extending to 0.7 of cercus length, with apex bifid and as wide as 0.8 of its basal width (Figure 16a).

Dimensions. Total length 46.5; abdomen length 30.3; Fw length 36.8; Hw length 35.5; Hw maximum width 10.3; cercus length 1.8; epiproct length 1.25; epiproct maximum width 1; epiproct subapical width 0.6.

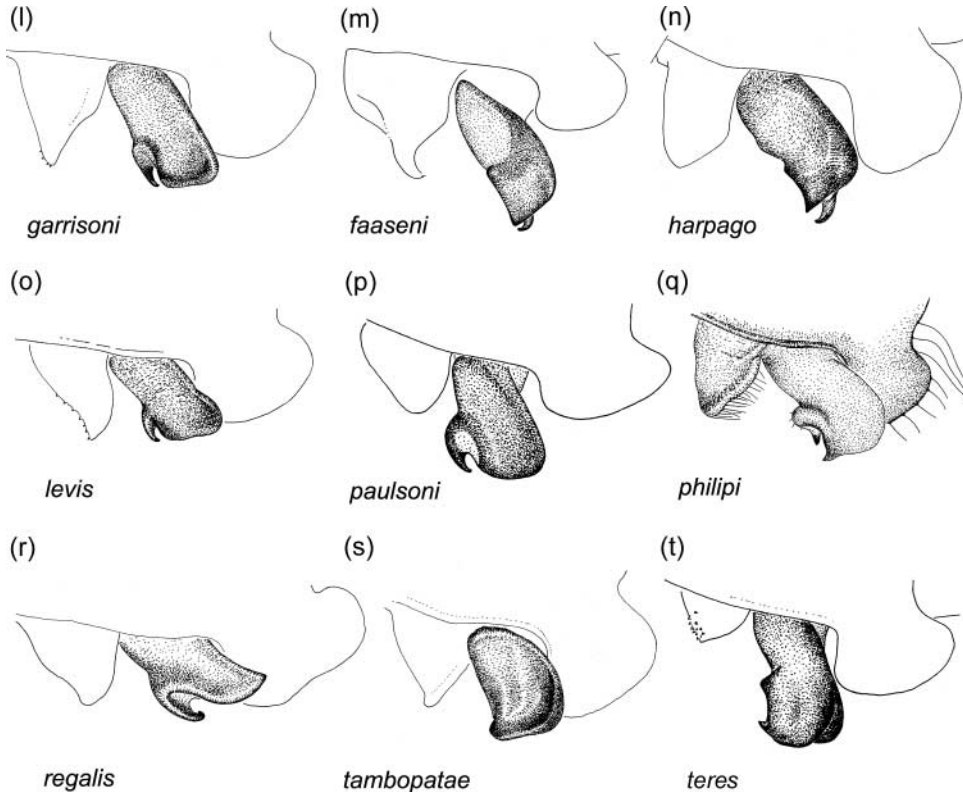


Figure 10. Continued. (l) *Orthemis garrisoni*, holotype; (m) *O. faaseni*, paratype; (n) *O. harpago*, holotype; (o) *O. levis*, Costa Rica, Hacienda Taboga; (p) *O. paulsoni*, holotype; (q) *O. philipi*, paratype, Argentina, E of Las Varas; (r) *O. regalis*, holotype, redrawn from Ris (1910); (s) *O. tambopatae*, paratype, Peru, Tambopata; (t) *O. teres*, holotype.

Variation in male paratypes

Head. As for holotype but labial palp medial black stripe as wide as 0.40–0.50 of palp width; in one paratype postclypeal lobes not fringed with dark line along distal margin; in one paratype labrum with pair of rounded laterobasal pale yellow spots.

Thorax. As for holotype but no pale stripes on mesepisternum and pale stripes on mesepimeron very faint in two paratypes; no pale stripes lateral to mediodorsal carina in three paratypes; 13–21 + 1 metafemoral spurs, +2 in one leg; arcus midway between Anx 2 and 3 in four paratypes; Fw discoidal field with 5–7 rows of cells at hind margin, Hw with 12–16 at hind margin; anal loop enclosing 21–27 cells. Pt 4.4–4.7 in Fw, 4.2–4.7 in Hw; Anx 16–18 in Fw, 13–15 in Hw; Pnx 13–18 in Fw, 14–18 in Hw.

Abdomen. As for holotype but dorsal terga of S1–2 orange red dorsally and S5 mostly red in three paratypes (Figure 19a), of S4 black with red mid-dorsal and ventrolateral stripes in one paratype; of S9 entirely black in one paratype; ratio S4 width/length: 0.30–0.37.

Dimensions ($n = 9$). Male total length 42.5–48.8; abdomen length 26.6–31.5; Fw length 36.7–39.4; Hw length 34.7–38; maximum Hw width 10.2–10.7; cercus length 1.65–1.9; epiproct length 1.2–1.4; epiproct maximum width 0.85–1.05; epiproct subapical width 0.6–0.7.

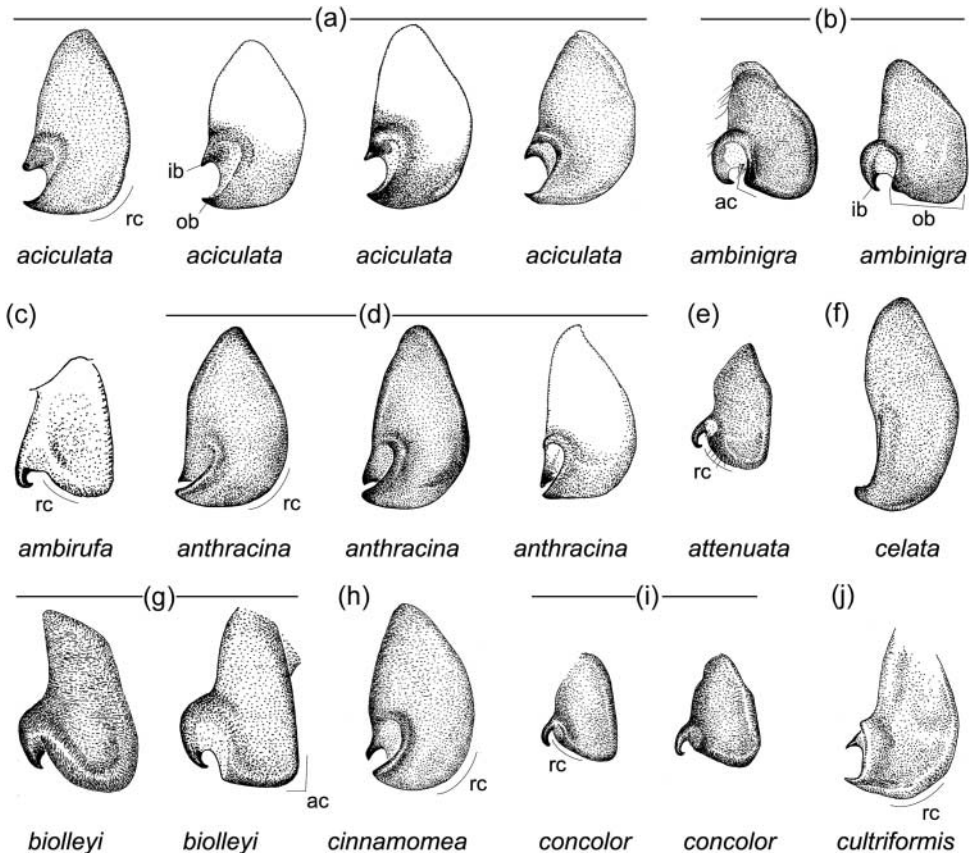


Figure 11. Male posterior hamule, frontal view (to scale) – (a) *Orthemis aciculata*, from left to right under black line: holotype; paratype, Surinam, Mapane; paratype, Peru, Tamshiyacu; paratype, Panama, Gamboa; (b) *O. ambinigra*, from left to right under black line: Argentina, SE Isla de Cañas; Brazil, Nova Teutonia, holotype of *O. plaumanni*; (c) *O. ambirufa*, holotype; (d) *O. anthracina*, from left to right under black line: Surinam, Werehpai; Surinam, Kabalebo; Peru, Tamshiyacu; (e) *O. attenuata*, Brazil, Cacauplandia; (f) *O. celata*, holotype; (g) *O. biolleyi*, from left to right under black line: Brazil, Ariquemes [NE]; French Guiana, Patawa [RWG]; (h) *O. cinnamomea*, holotype; (i) *O. concolor*, from left to right under black line: Trinidad, Aripo; French Guiana, Cacao; (j) *O. cultriformis*, lectotype. Figure 11c, j, by RWG. Abbreviations: ac: angled corner; ib: inner branch; ob: outer branch; rc: rounded corner.

Average dimensions ($n = 10$). Male total length 45.67 ± 1.75 ; abdomen length 29.17 ± 1.34 ; Fw length 37.74 ± 1.02 ; Hw length 36.33 ± 0.97 ; maximum Hw width 10.42 ± 0.16 ; cercus length 1.79 ± 0.07 ; epiproct length 1.31 ± 0.08 ; epiproct maximum width 0.96 ± 0.06 ; epiproct subapical width 0.62 ± 0.03 .

Variation in female paratypes

Head. As for holotype but medial black stripe of labial palp as wide as 0.33–0.40 of palp width (Figure 1a–b); labrum reddish brown with black along distal margin and pair of yellow laterobasal spots; ventral half of antefrons pale brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex pale to dark reddish brown, occipital triangle pale to dark reddish brown, rear of head reddish brown with two yellow spots behind eyes.

Thorax. As for holotype but prothorax reddish brown except anterior lobe, mediodorsal area of middle lobe, and posterior margin of posterior lobe yellow. Pterothorax (Figure 2b–c) as for

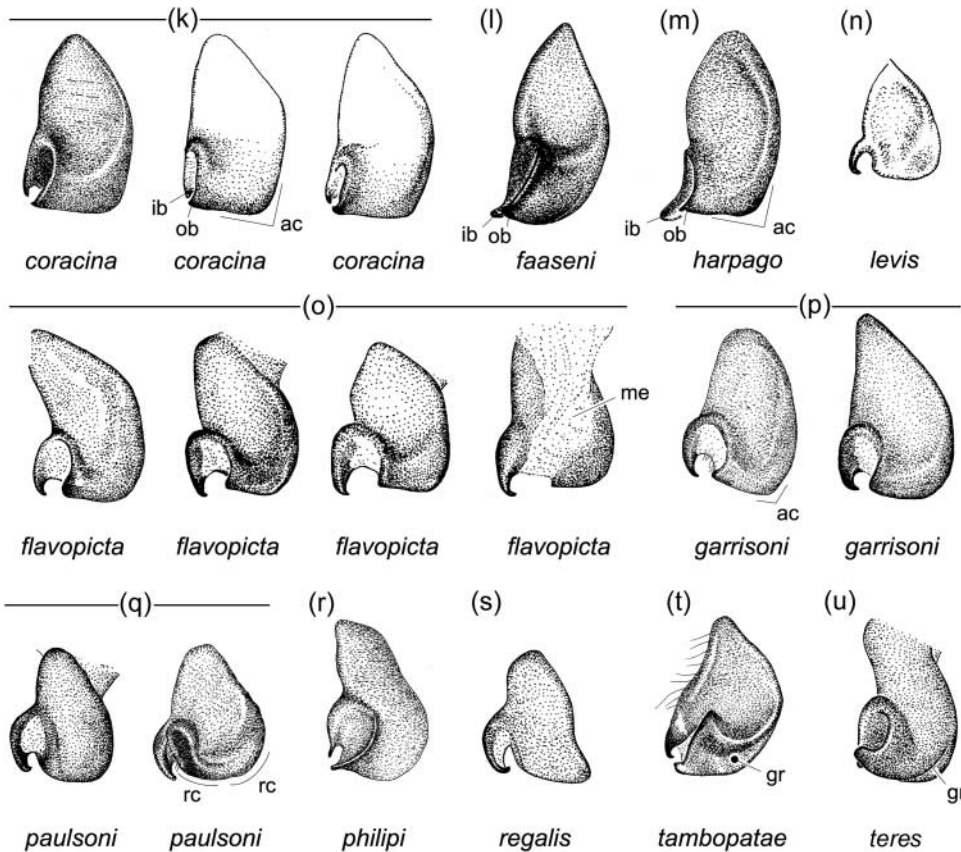


Figure 11. Continued. (k) *O. coracina*, from left to right under black line: holotype; Peru, Tamshiyacu; Surinam, Werehpai; (l) *O. faaseni*, paratype; (m) *O. harpago*, holotype; (n) *O. levis*, Costa Rica, Hacienda Taboga; (o) *O. flavopicta*, from left to right under black line: lectotype; Brazil, Cacaupallia; Brazil, Jatai; inner view Brazil, Lauro de Freitas; (p) *O. garrisoni*, from left to right under black line: holotype; paratype, Panama, Gamboa; (q) *O. paulsoni*, from left to right under black line: holotype; paratype, Peru, Tambopata; (r) *O. philipi*, paratype, Argentina, E of Las Varas; (s) *O. regalis*, Surinam, Tapanahori River; (t) *O. tambopatae*, paratype, Peru, Tambopata; (u) *O. teres*, holotype. ac: angled corner; ca: carina; gr: groove; me: membranous area; rc: rounded corner: Figure 11n by RWG.

holotype but sometimes a narrow stripe along medial third of mesepisternal–mesepimeral carina; mesepimeron with triangular spot on anterodorsal corner; metafemur armed with 12–19 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur; arcus between Anx 2 and Anx3, usually closer to Anx 2, sometimes midway; Fw discoidal field with 3 rows of cells at base to 4–6 rows at hind margin, Hw with 2–3 at base, then 2, then increasing to 12–17 at hind margin; anal loop enclosing 22–26 cells. Pt orange to reddish brown, overlying 4–6 cells. Anx: 14–17 in Fw, 12–15 in Hw; Pnx: 14–18 in Fw, 15–18 in Hw.

Abdomen. As in holotype but S4 as long as ca. twice to almost three times its apical width (ratio width/length = 0.38–0.53). Dorsal terga (Figure 7a) with mid-dorsal carina bordered by yellow in S1–4, and by pale orange in S5–7; S1–3 pale reddish brown with ventral third yellow; S4–7 pale orange red with medial third diffusely brown to dark reddish brown or black; S8 dark reddish brown to black with ventrolateral flap pale yellow; S9–10 and caudal appendages dark reddish brown to black. Ventrolateral carina on S2 vestigial, on S3–7 well developed and black. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 8a) reddish brown with yellow stripe along ventrolateral carinae on S1–6, orange in S7; S8 pale yellow; S9–10

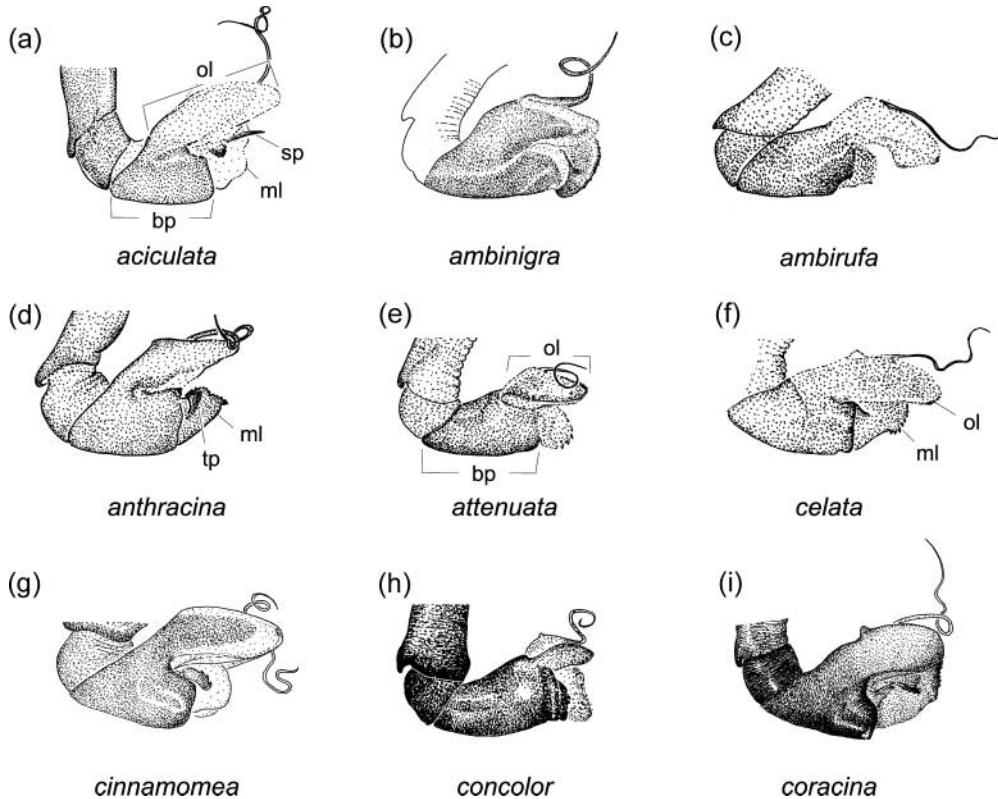


Figure 12. Male vesica spermalis, lateral view (to scale)–(a) *Orthemis aciculata*, holotype; (b) *O. ambinigra*, Argentina, SE Isla de Cañas; (c) *O. ambirufa*, French Guiana, Tonate; (d) *O. anthracina*, Peru, Tamshiyacu; (e) *O. attenuata*, Brazil, Encontro das Aguas; (f) *O. celata*, holotype; (g) *O. cinnamomea*, paratype, Ecuador, Limoncocha; (h) *O. concolor*, French Guiana, Cacao; (i) *O. coracina*, holotype. Abbreviations: bp: basal portion; ml: medioectal lobe; ol: outer lobe; sp: splinter-shaped lateral projection; tp: triangular lateral projection.

dark reddish brown. Vulvar lamina on S8 extending along posterior 0.20 of S8 length, consisting of an anterior transverse ridge and a medial longitudinal ridge extending to S8 posterior margin, bordered lateroposteriorly by semicircular ribs (Figure 18a–b).

Dimensions ($n = 8$). Total length 44.1–49.2 [46.48 ± 1.96]; abdomen length 28–34 [30.61 ± 1.9]; Fw length 35.2–39.3 [37 ± 1.31]; Hw length 33.8–38.4 [35.83 ± 1.37]; maximum Hw width 9.4–10.4 [9.60 ± 0.55]; Fw Pt length 4.1–4.9 [4.46 ± 0.24]; Hw Pt 4–4.7 [4.29 ± 0.23]; S4 ratio apical width/length 0.38–0.52 [0.46 ± 0.06]; ventrolateral flap on S8 length 2.67–3.1 [2.9 ± 0.14], width 0.9–1 [0.94 ± 0.03]; ratio width/length 0.3–0.34 [0.32 ± 0.02]; cercus length 1.35–1.5 [1.41 ± 0.06], epiproct length 0.4–0.7 [0.57 ± 0.11].

Diagnosis

Male of *O. aciculata* shares apex of epiproct wide, ca. 0.50 of epiproct maximum width or wider, only with *O. anthracina*, *O. celata*, *O. cinnamomea*, *O. coracina*, and *O. harpago* (Figure 16a, d, f, g–h, j, l, o). It differs from all of them by the splinter-shaped lateral projection on medioectal lobe of vesica spermalis distal segment (Figure 13a; versus no sclerotized projections or of different shape, Figure 13d, d, g–h, m), and by hamule shape, with inner and outer branches ca. equally long (Figure 11a; versus inner branch longer than outer branch in *O. harpago*, Figure 11m),

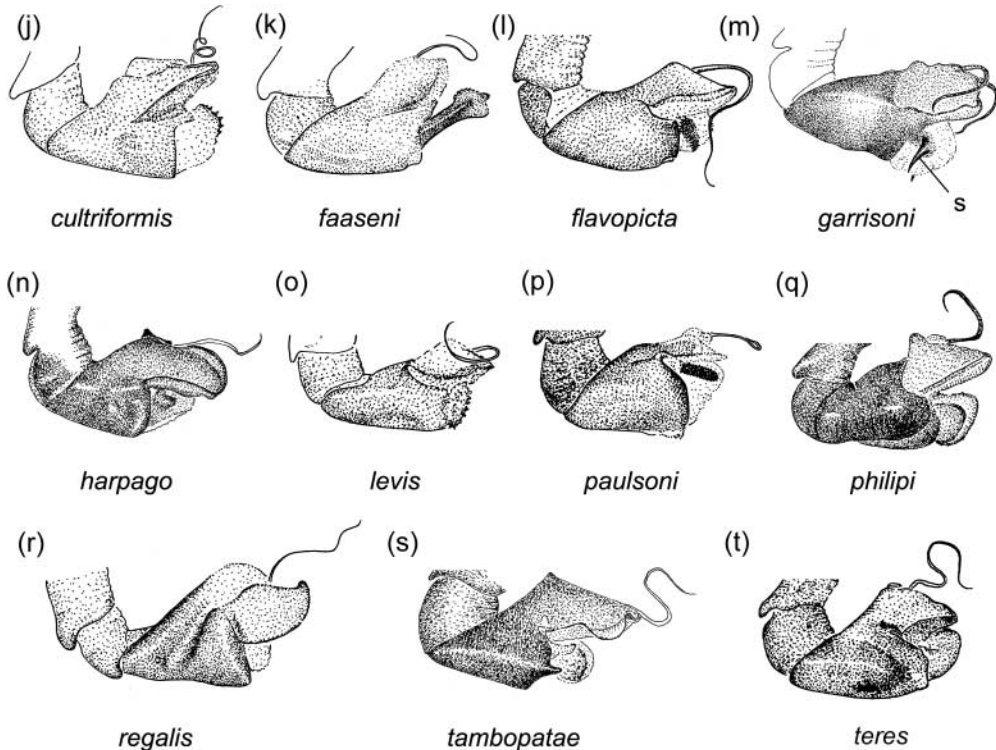


Figure 12. Continued. (j) *O. cultriformis*, Peru, Pakitza; (k) *O. faaseni*, holotype; (l) *O. flavopicta*, lectotype ; (m) *O. garrisoni*, holotype; (n) *O. harpago*, holotype; (o) *O. levis*, Guatemala, Santa Lucía; (p) *O. paulsoni*, holotype; (q) *O. philipi*, paratype, Argentina, E of Las Varas; (r) *O. regalis*, Surinam, Tapanahori River; (s) *O. tambopatae*, paratype, Peru, Tambopata; (t) *O. teres*, holotype. Abbreviation: s: spine.

and separated by distance of ca. twice inner branch length (inner branch almost touching tip of outer branch in *O. anthracina*, *O. celata*, *O. cinnamomea*, and *O. coracina*, Figure 11d, f, h, k).

Female shares a similar vulvar lamina, characterized by the presence of a transverse and a medial longitudinal ridge anterior to posterior margin of sternum S8, with *O. anthracina*, *O. cinnamomea*, *O. coracina*, *O. cultriformis*, *O. faaseni*, and *O. harpago* (Figure 18a–b, g–h, j–l, o). Among them, it shares the transverse anterior ridge lacking lateral or anterior triangular projections only with *O. cultriformis*; it differs from *O. cultriformis* by the lateral ends of the transverse ridge not projected posteriorly (Figure 18a–b; versus projected posteriorly, Figure 18k).

Remarks

Several specimens of this species from Surinam were misidentified as *O. flavopicta* [RMNH, Belle, 2002], one male from Panama as *O. anthracina* [RWG, von Ellenrieder, 2009], and one female from Trinidad as *O. cultriformis* [RWG, von Ellenrieder, 2009]. Correlation of shape of vesica spermalis and hamule in a relatively large series of specimens, and association of males and females based on distribution, allows me to conclude that this is a separate undescribed species.

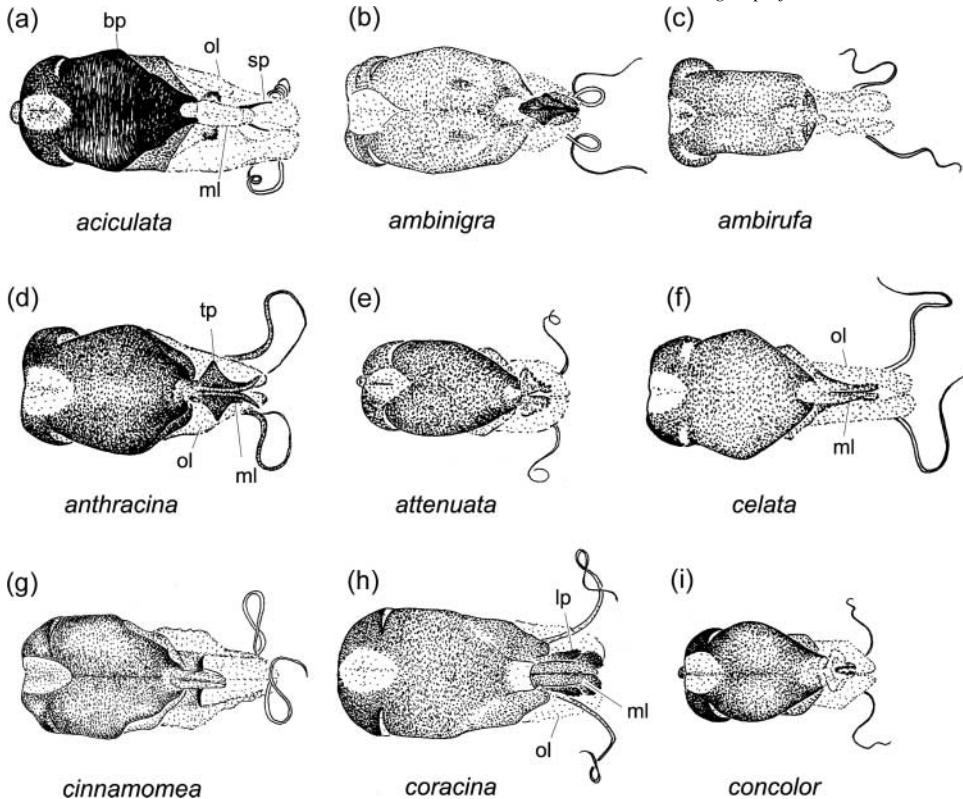


Figure 13. Male vesica spermalis, ectal view (to scale) – (a) *Orthemis aciculata*, holotype; (b) *O. ambinigra*, Brazil, Nova Teutonia, holotype of *O. plaumanni*; (c) *O. ambirufa*, French Guiana, Tonate; (d) *O. anthracina*, Peru, Tamshiyacu; (e) *O. attenuata*, Brazil, Encontro das Aguas; (f) *O. celata*, holotype; (g) *O. cinnamomea*, paratype, Ecuador, Limoncocha; (h) *O. coracina*, holotype; (i) *O. concolor*, Trinidad, Aripo. Abbreviations: bp: basal portion; lp: lateral projection; ml: medio-ectal lobe; ol: outer lobe; sp: splinter-shaped lateral projection; tp: triangular lateral projection.

Distribution and biology

Known distribution extends from Panama south to Trinidad, Surinam, N Brazil, and N Peru (Figure 25). Specimens of the type series were collected along rivers, roads, ponds, and swamps within tropical forest areas.

Orthemis ambinigra Calvert, 1909

Figures 2d, 5a, 6b, 7b, 8b, 10b, 11b, 12b, 13b, 14b, 15c, 16b, 17b, 18c, 22

Orthemis ambinigra Calvert, 1909, p. 246 (description; holotype male from Rio de Janeiro, Brazil, in CMNH); Ris (1910, pp. 280, 289; key, description of female); Ris (1919, p. 1104, new records); von Ellenrieder (2009, pp. 349, 374, 380, figures 8c, 9c, 14c, 15c, 21, table 1; illustrations of hamule and S10, map, inclusion in key).

Orthemis cultriformis nec Calvert, 1899. – Ris (1904, p. 42; misidentification).

Orthemis plaumanni Buchholz, 1950, pp. 80–81, figure 2 (description, illustration of genital fossa in lateral view; holotype male from Nova Teutonia, Santa Catarina State, Brazil, in ZFMK) – **new synonymy**.

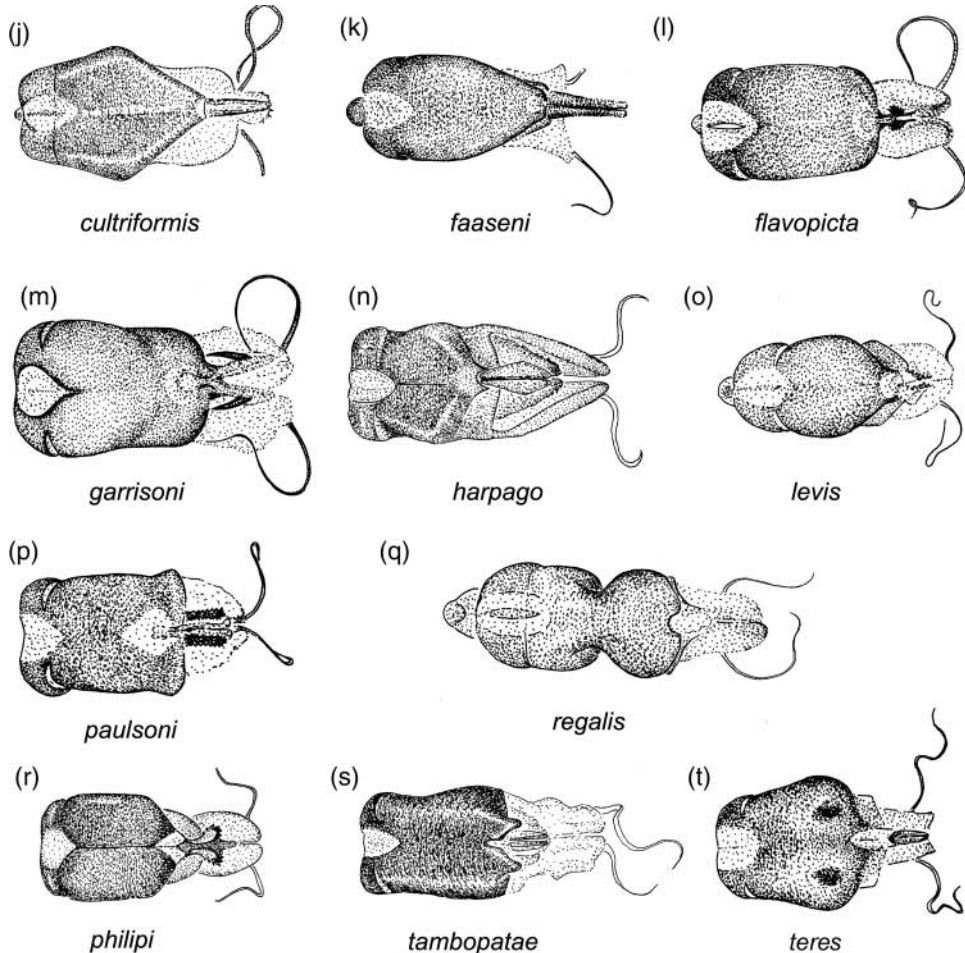


Figure 13. Continued. (j) *O. cultriformis*, Peru, Pakitza; (k) *O. faaseni*, holotype; (l) *O. flavopicta*, lectotype; (m) *O. garrisoni*, holotype; (n) *O. harpago*, holotype; (o) *O. levis*, Guatemala, Santa Lucia; (p) *O. paulsoni*, holotype; (q) *O. regalis*, Surinam, Tapanahori River; (r) *O. philipi*, paratype, Argentina, E of Las Varas; (s) *O. tambopatae*, paratype, Peru, Tambopata; (t) *O. teres*, holotype.

Type specimens examined

1 ♂ Holotype: Brazil, Rio de Janeiro State, Rio de Janeiro (22°54' S, 43°14' W), January 1886, leg. H.H. Smith [CMNH].

Other specimens examined

Total 18 ♂, 7 ♀: 1 ♂, Brazil, Rio de Janeiro State, Rio de Janeiro, Vista Chinesa, Reserva Florestal Estadual Vista, Alto Boa Vista (22°54'29" S, 43°13'32" W), 16 February 2009, leg. A.P. Pinto [DZRJ]; 1 ♂, same but water storage channel [DZRJ]; 1 ♂, Brazil, Rio de Janeiro State, Parna da Floresta da Tijuca (22°57'22" S, 43°16'48" W), 17 February 2010, leg. A.P. Pinto [DZRJ]; 1 ♂, holotype of *O. plaumanni* Buchholz, 1950, Brazil, Santa Catarina State, Nova Teutonia (27°03' S, 52°24' W), 14 January 1949, leg. F. Plaumann [ZFMK]; 1 ♂, same but 12 January 1942 [RWG]; 2 ♂, Brazil, Rio Grande do Sul State, Porto Alegre, Ilha do Pavao, Posto Fiscal da Secretaria da Fazenda/RS, margens Rio Guaiba (29°59'46" S, 51°12'49" W), 4 January 2008, leg. A.P.

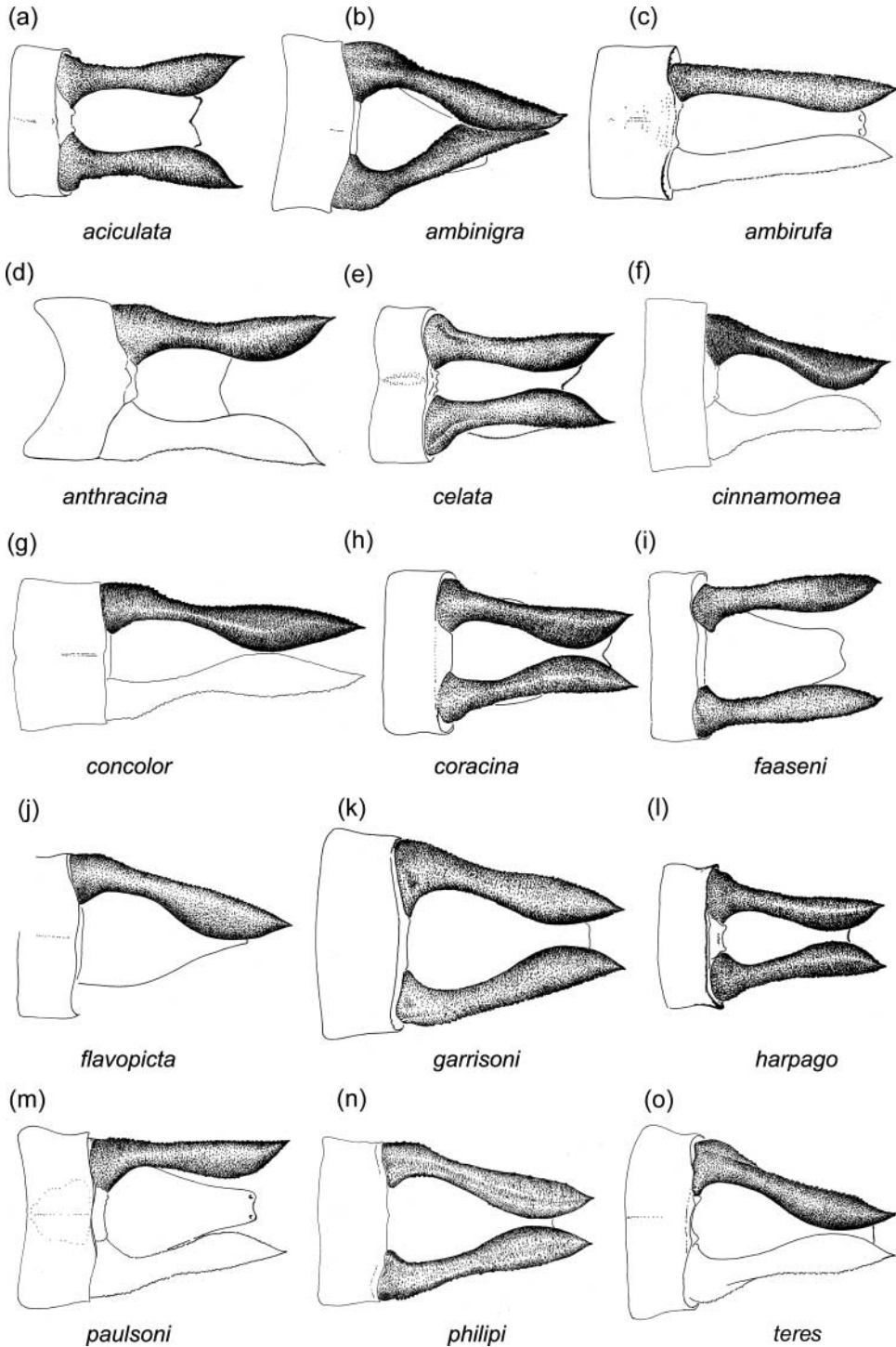


Figure 14. Male S10, dorsal view (to scale) – (a) *Orthemis aciculata*, holotype; (b) *O. ambinigra*, Brazil, Nova Teutonia, holotype of *O. plaumanni*; (c) *O. ambirufa*, Brazil, Tapirape-Araguaia; (d) *O. anthracina*, Surinam, Werehpai; (e) *O. celata*, holotype; (f) *O. cinnamomea*, holotype; (g) *O. concolor*, French Guiana, Cacao; (h) *O. coracina*, holotype; (i) *O. faaseni*, paratype; (j) *O. flavopicta*, lectotype; (k) *O. garrisoni*, holotype; (l) *O. harpago*, holotype; (m) *O. paulsoni*, holotype; (n) *O. philipi*, holotype; (o) *O. teres*, holotype.

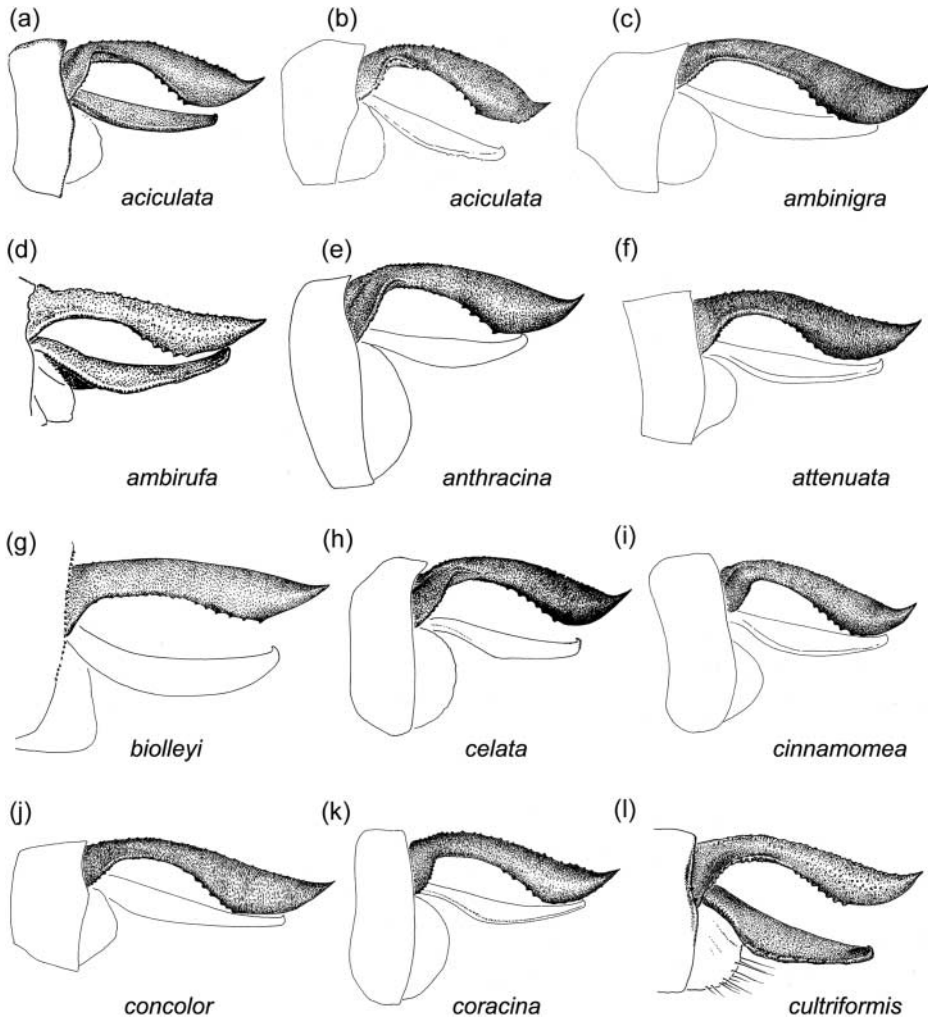


Figure 15. Male S10, lateral view (to scale) – (a) *Orthemis aciculata*, holotype; (b) *O. aciculata*, paratype, Panama, Gamboa; (c) *O. ambinigra*, Argentina, Punta Lara; (d) *O. ambirufa*, holotype; (e) *O. anthracina*, Surinam, Werekpai; (f) *O. attenuata*, Peru, Susuari; (g) *O. biolleyi*, French Guiana, Patawa [RWG]; (h) *O. celata*, holotype; (i) *O. cinnamomea*, holotype; (j) *O. concolor*, Trinidad, Aripo; (k) *O. coracina*, holotype; (l) *O. cultriformis*, lectotype. Figure 15d, l by RWG.

Pinto [DZRJ]; 1 ♂, Argentina, Misiones Prov., Iguazú (25°34' S, 54°34' W), 8 December 1984, leg. D.A.L. Davies [RWG]; 2 ♂, Argentina, Misiones Prov., shaded pond by Ruta 2 (25°51'5" S, 54°35'15" W), 1 February 2012, leg. NE & RWG [RWG]; 1 ♂, Argentina, Misiones Prov., Montecarlo (26°34' S, 54°47' W), January 1940 [IFML]; 1 ♂, Argentina, Salta Prov., stream 20 km SE of Isla de Cañas (22°57'30" S, 64°33'20" W), 22 May 2008, leg. NE [NE]; 1 ♀, Argentina, Corrientes Prov., Arroyo Pay Ubre, Route 29 ca. 25 km N of Mercedes (29°01'41" S, 58°10'28" W), 23 February 2003, leg. P. Pessacq & J. Muzón [MLP]; 1 ♂, 1 ♀, Argentina, Buenos Aires Prov., San Fernando (34°09'37" S, 58°44'45" W), 1 January–31 March 1967, leg. J. Daguerre [FSCA]; 1 ♂, 1 ♀ same but [RWG]; 1 ♀, same but camping Cielo, 8 January 1999, leg. NE & J. Muzón [NE]; 1 ♀, same but Campana, Delta del Paraná, between Otamendi and San Fernando (34°07'51" S, 58°49'08" W), 18 February 1998 [RWG]; 2 ♂, Argentina, Buenos Aires Prov., Punta Lara, forest (34°49' S, 57°59' W), 23 January 1997, leg. NE [NE]; 1 ♂ same but [RWG]; 1 ♀, Argentina, Buenos Aires Prov., Victoria (34°27'37" S, 58°32'00" W), 23 December 1938, leg.

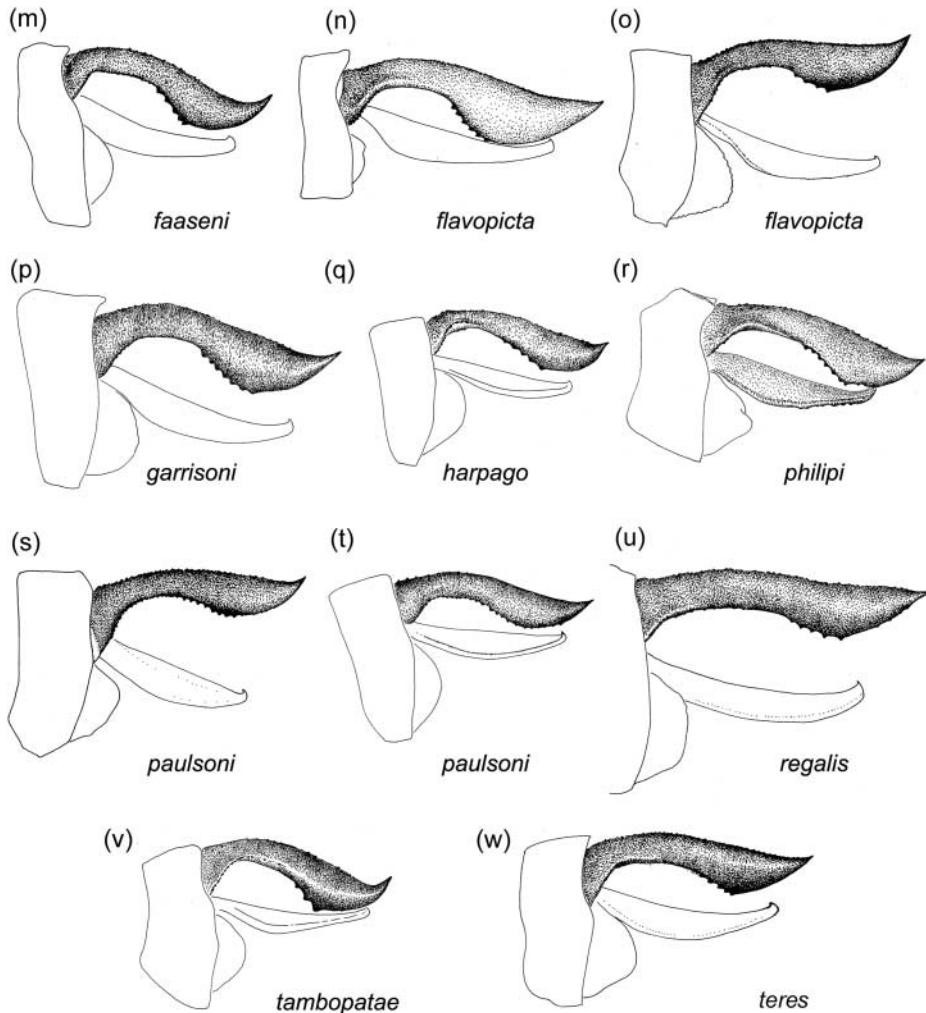


Figure 15. Continued. (m) *O. faaseni*, paratype; (n) *O. flavopicta*, lectotype; (o) *O. flavopicta*, Brazil, Cacauplandia; (p) *O. garrisoni*, holotype; (q) *O. harpago*, holotype; (r) *O. philipi*, paratype, Argentina, E of Las Varas; (s) *O. paulsoni*, holotype; (t) *O. paulsoni*, paratype, Peru, Tambopata; (u) *O. regalis*, Surinam, Tapanahori River; (v) *O. tambopatae*, paratype, Peru, Tambopata; (w) *O. teres*, holotype.

H. Gloger [IFML]; 1 ♂ same but 30 December 1937 [IFML]; 1 ♂ same but Punta Chica (34°28' S, 58°31' W), 6 January 1940 [IFML]; 1 ♀ same but 2 February 1941 [IFML]; 1 ♀ Uruguay, Rivera Dept., Tranqueras, Arroyo Tacuarembó, Route 3, km 251 (31°10'40" S, 55°45'44" W), 19 February 2008, leg. D. Emmerich & C. Molineri [IFML].

Diagnosis

Male of *O. ambinigra* has metallic blue to purple frons and vertex, labial palp with medial black stripe as wide as 0.66 of each palp or more, pterothorax brown with yellow stripes, and abdomen red except for carinae narrowly black and a black mediodorsal longitudinal spot on S8–9 (Figure 5a). Abdomen narrows gradually from S2 to S4 (Figure 6b), and S4 is about as wide at level of apical carina as 0.35–0.50 of its length. Hamule inner and outer branches are located in the same plane (Figure 10b), with both ending at about the same level; inner corner

of outer branch is angled, and outer corner is smoothly rounded (Figure 11b). Distal segment of vesica spermalis is trapezoidal, with sides slightly convex and maximum width near mid-length of basal sclerotized portion in ectal view (Figure 13b), with paired distal medial longitudinal membranous lobes beset with denticles along distal margin on ectal side, paired outer lateral lobes shorter than basal sclerotized portion and folded medially to the sides, and paired flagella (Figures 12b, 13b). Cercus curves ventrally gradually (Figure 15c) and is widest at base in dorsal view (Figure 14b). Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16b).

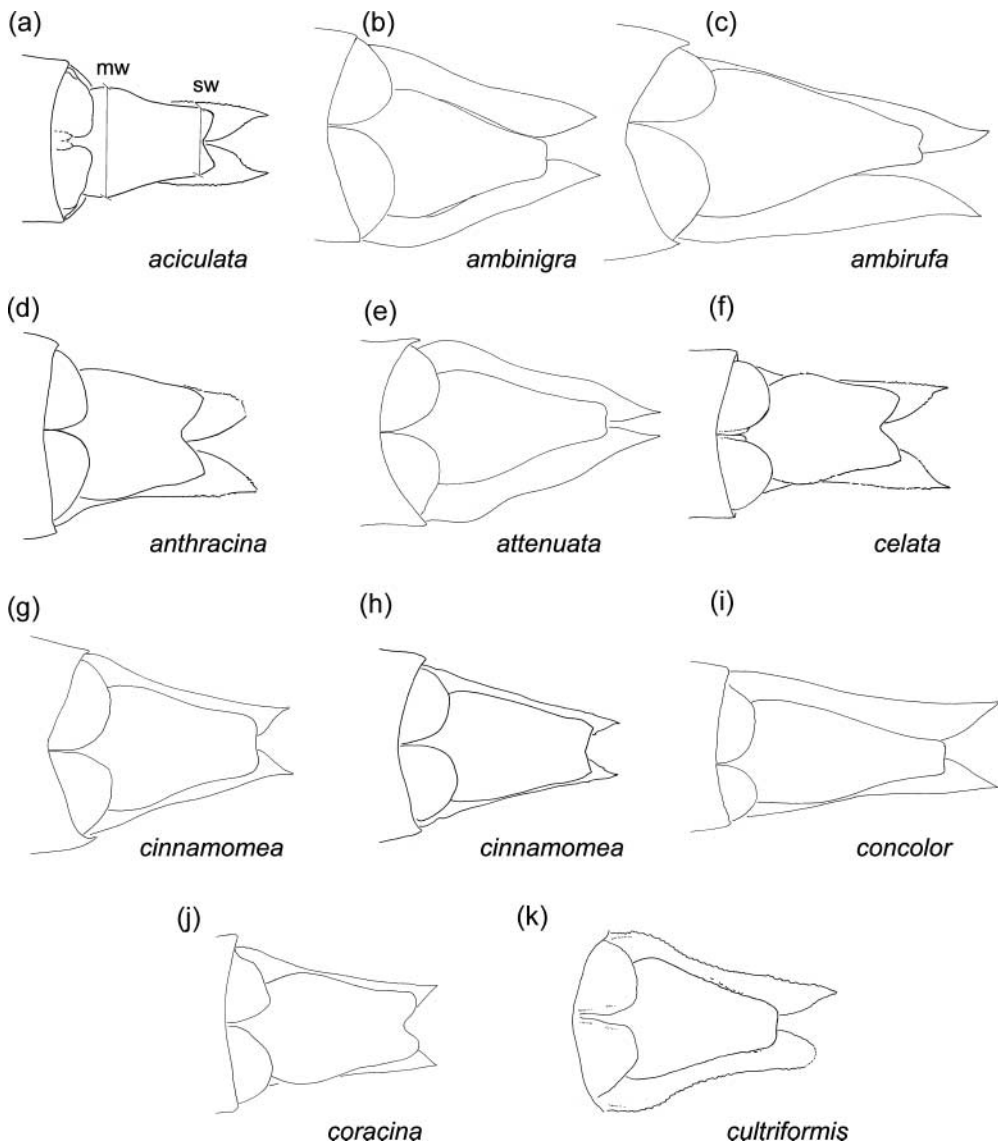


Figure 16. Male S10, ventral view (to scale) – (a) *Orthemis aciculata*, holotype; (b) *O. ambinigra*, Argentina, Punta Lara; (c) *O. ambirufa*, French Guiana, Tonate; (d) *O. anthracina*, Peru, Tamshiyacu; (e) *O. attenuata*, Peru, Sucusari; (f) *O. celata*, holotype; (g) *O. cinnamomea*, holotype; (h) *O. cinnamomea*, paratype, Ecuador, Sucumbios; (i) *O. concolor*, Trinidad, Aripo; (j) *O. coracina*, holotype; (k) *O. cultriformis*, lectotype. Figure 16k RWG. Abbreviations: mw: maximum width of epiproct; sw: subapical width of epiproct.

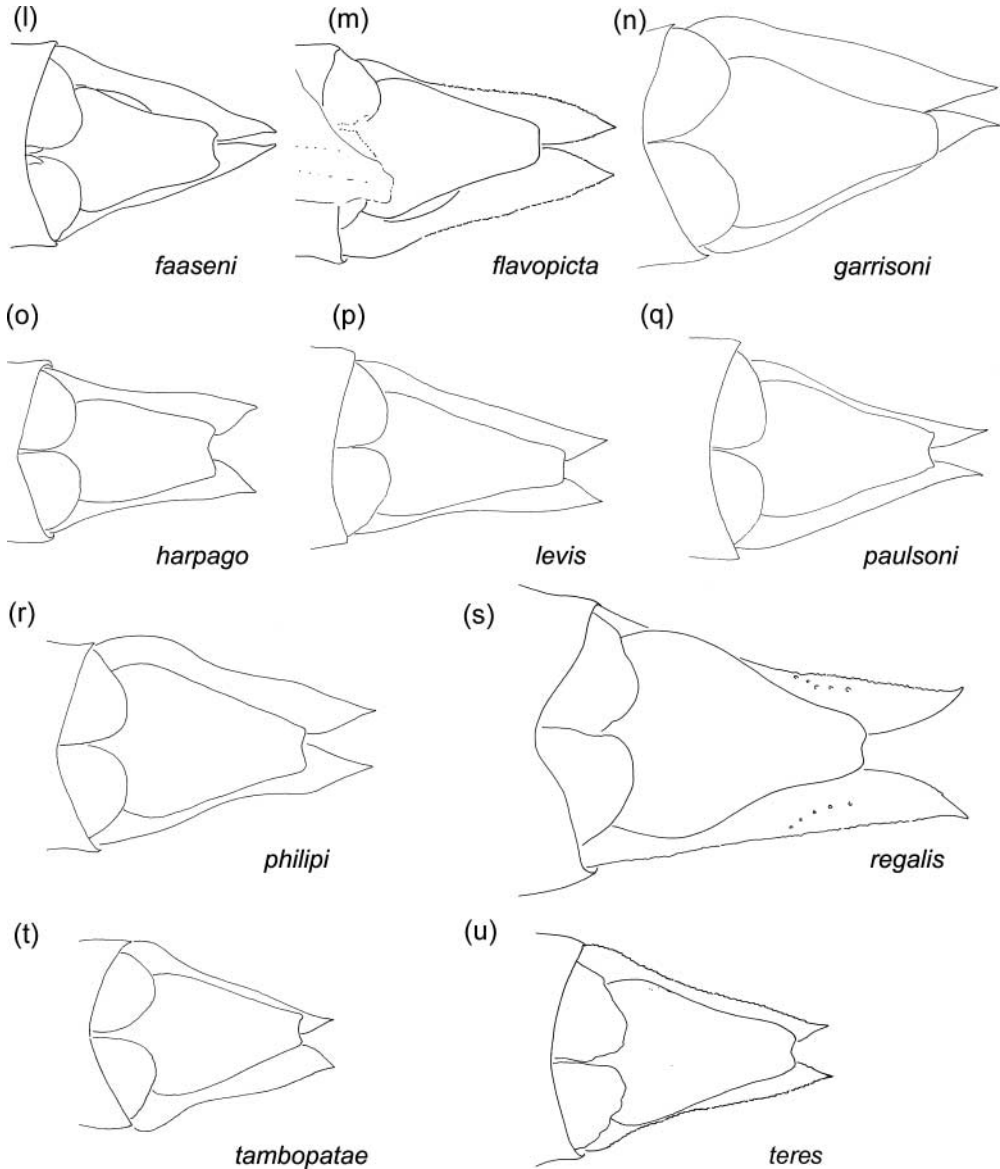


Figure 16. Continued. (l) *O. faaseni*, paratype; (m) *O. flavopicta*, paralectotype, Brazil, "Pará"; (n) *O. garrisoni*, holotype; (o) *O. harpago*, holotype; (p) *O. levis*, Costa Rica, Taboga, Tambopata; (q) *O. paulsoni*, paratype, Peru, Tambopata; (r) *O. philipi*, paratype, Argentina, E of Las Varas; (s) *O. regalis*, Surinam, Tapanahori River; (t) *O. tambopatae*, paratype, Peru, Tambopata; (u) *O. teres*, holotype.

Within the *levis* group, male of *O. ambinigra* shares combination of a mostly red abdomen gradually narrowing at base, epiproct narrow at apex, and hamule with inner and outer branches in about the same plane only with *O. ambirufa*, *O. tambopatae*, and *O. teres* (Figure 11b–c, t–u). It differs from all of them by the wider extension of black on premental palps (0.60 or more versus 0.40 or less, with the possible exception of *O. teres* known only from the holotype missing labium), S8–9 with black mediodorsal stripe (versus S8–9 or at least S8 entirely red dorsally), and shape of outer branch of hamule (Figure 11b), with inner corner angled (inner corner rounded in

O. ambirufa, Figure 11c) and outer surface not grooved (grooved in *O. tambopatae* and *O. teres*, Figure 11t–u).

Female shares with male: labial palp with wide medial black stripe (0.50 or more of each palp), pterothorax brown with yellow stripes (Figure 2d), abdomen narrowing gradually from S2 to S4 (Figures 7b, 8b), and S4 about as wide at level of apical carina as 0.35–0.50 of its length. Color of abdomen is pale orange to reddish brown, with yellow stripes and brown diffuse spots (Figures 7b, 8b), and black mid-dorsal stripes on S7–9 to S8–9. Ventrolateral flap on S8 is pale yellow and relatively wide, ca. 0.28–0.34 as wide as its length, with a smoothly curved contour (Figure 17b). Vulvar lamina consists of an inverted U-shaped ridge anterior to posterior margin of S8, shared with females of *O. flavopicta* and *O. garrisoni*. However, it differs from them by the ridge being thin and laminar (Figure 18c), versus swollen with a rounded cross section (Figure 18m–n).

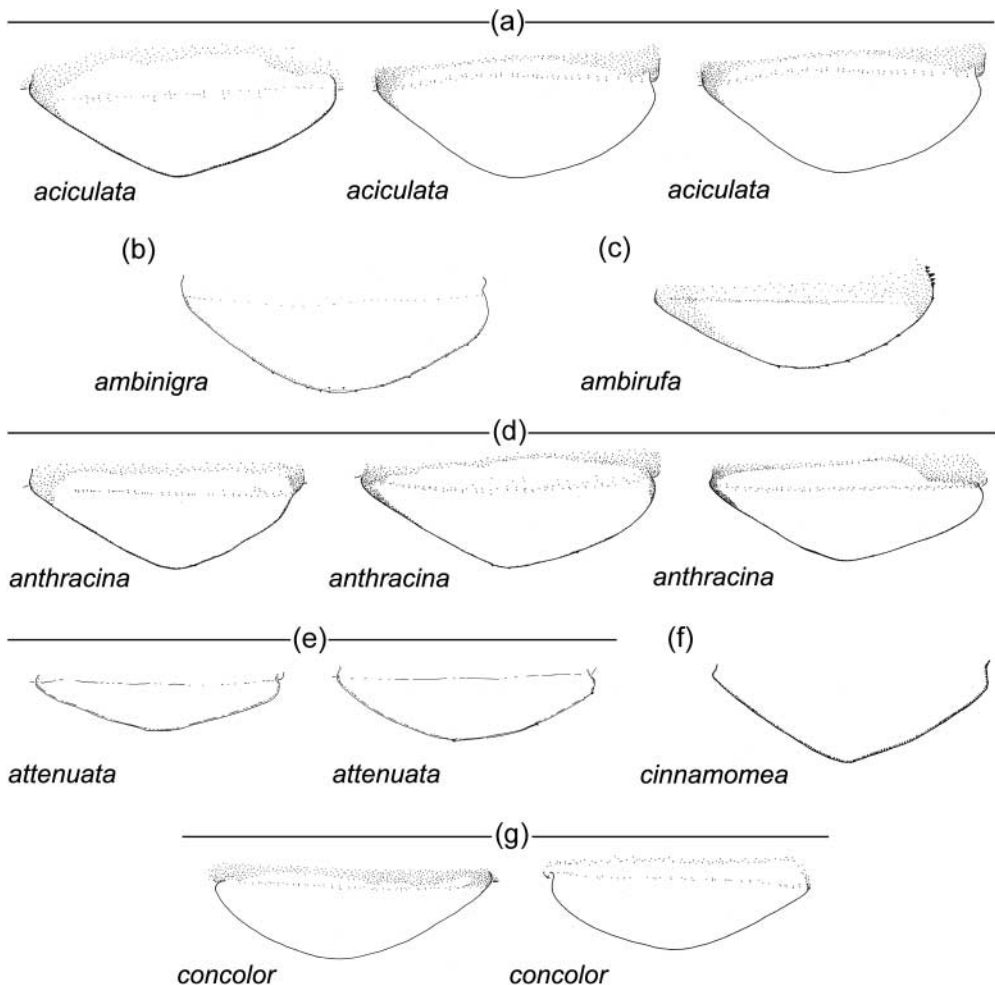


Figure 17. Lateral flap on female S8, lateral view (to scale) – (a) *Orthemis aciculata*, paratypes, from left to right under black line: Surinam, Pontijbrug; Trinidad, Aripo; Brazil, “Pará”; (b) *O. ambinigra*, Argentina, San Fernando; (c) *O. ambirufa*, Colombia, Río Guejar; (d) *O. anthracina*, Peru, Tamshiyacu, from left to right under black line: 30 July, 2 August, 10 August; (e) *O. attenuata*, from left to right under black line: Colombia, Fundación; Peru, Yarinacocha; (f) *O. cinnamomea*, paratype; (g) *O. concolor*, from left to right under black line: paralectotype, French Guiana, Georgetown; Trinidad, Aripo.

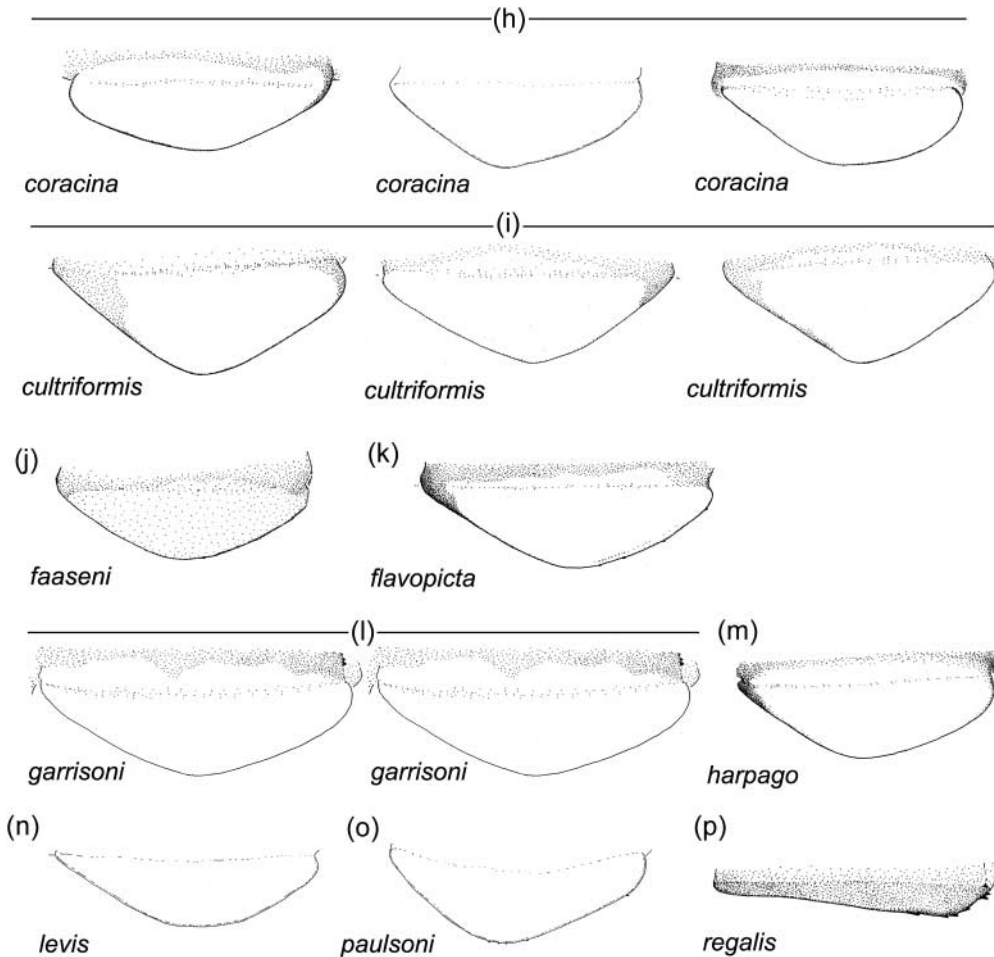


Figure 17. Continued. (h) *O. coracina*, from left to right under black line: Brazil, Rio Gurupí; Surinam, Sipaliwini; Surinam, Aranavero; (i) *O. cultriformis*: from left to right under black line: Peru, Pakitza; Brazil, Cacauplandia; Brazil, Rio Gurupí; (j) *O. faaseni*, paratype, Peru, Tamshiyacu; (k) *O. flavopicta*, Brazil, Lauro de Freitas; (l) *O. garrisoni*, paratypes, Panama, Gamboa, from left to right under black line: 20 June 1936; 22 May 1937; (m) *O. harpago*, Peru, Aguas Negras; (n) *O. levis*, Venezuela, Carabobo; (o) *O. paulsoni*, paratype, Peru, Tambopata; (p) *O. regalis*, Surinam, Brownsweeg.

Remarks

Buchholz's (1950) description of *O. plaumanni* was based on three males from Nova Teutonia, Santa Catarina, Brazil. He did not include illustrations except for a lateral view of the genital fossa, his diagnosis from other species in the *levis* group of *Orthemis* being based solely on the presence of two bridge crossveins. Even though some specimens from Peru I examined earlier (identified as *O. plaumanni* in von Ellenrieder, 2009) seemed to fit well the description of *O. plaumanni* in terms of venation and color, the shape of male hamule differed from that illustrated by Buchholz (1950) for that species and approached that of *O. ambinigra* instead. In order to confirm the correct application of the name, I borrowed the holotype of *O. plaumanni* from ZFMK, and its examination revealed that *O. plaumanni* is a junior synonym of *O. ambinigra*, confirmed by direct comparison with the type of *O. ambinigra*, from Rio de Janeiro, Brazil, borrowed from CMNH. The species I previously identified as *O. plaumanni* (von Ellenrieder, 2009) represents an undescribed species (see under *O. paulsoni*). Shape of hamule, vesica spermalis, cerci, epiproct,

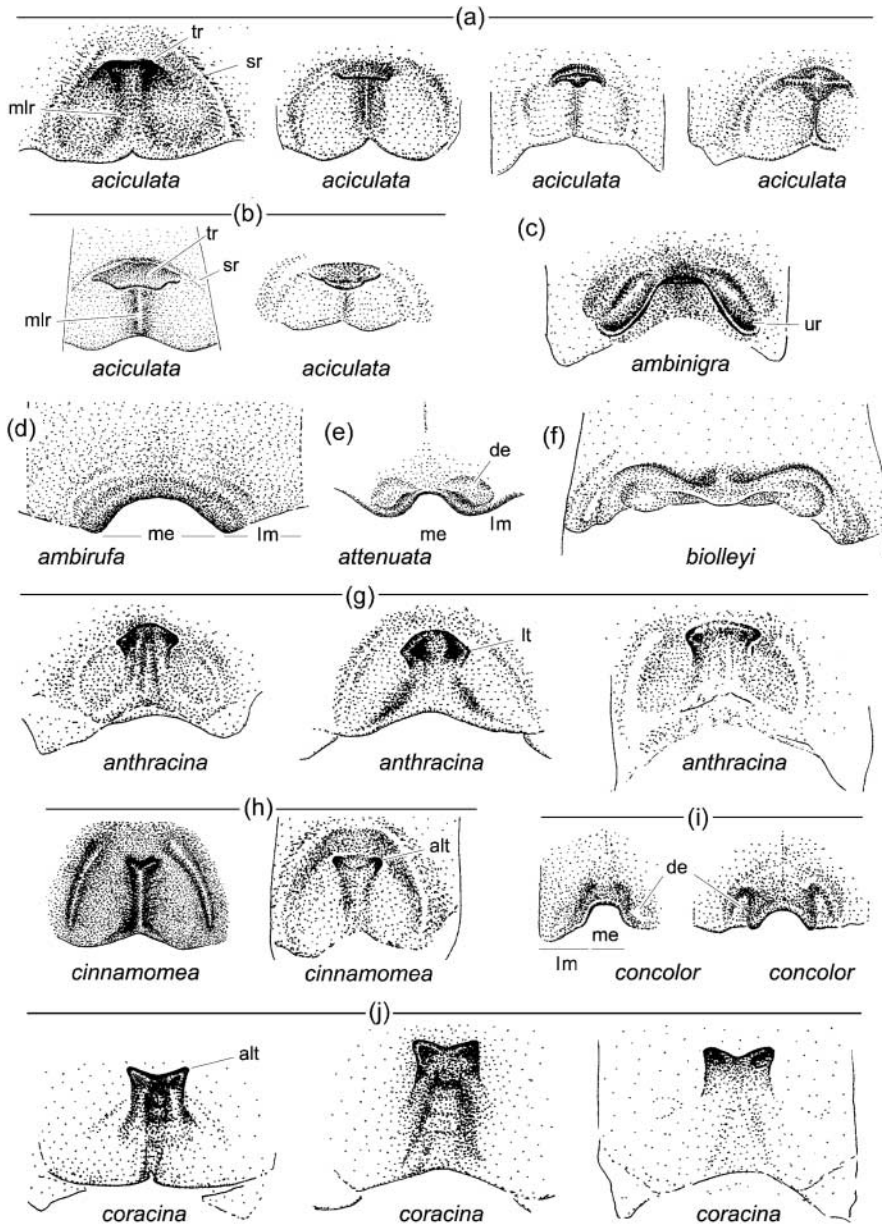


Figure 18. Vulvar lamina, ventral view (to scale) – (a) *Orthemis aciculata*, paratypes, from left to right under black line: Surinam, Pontijbrug; Trinidad, Aripo; Trinidad, S of Valencia; paralectotype *O. flavopicta*, Brazil, “Pará”; (b) *O. aciculata*, ventro-posterior view, paratypes, from left to right under black line: Trinidad, Aripo; paralectotype *O. flavopicta*, Brazil, “Pará”; (c) *O. ambinigra*, Argentina, San Fernando; (d) *O. ambirufa*, Colombia, Río Guejar; (e) *O. attenuata*, Peru, Yarinacocha; (f) *O. biolleyi*, French Guiana, Cacao [NE]; (g) *O. anthracina*, Peru, Tamshiyacu, from left to right under black line: 30 July, 2 August, 10 August; (h) *O. cinnamomea*, from left to right under black line: paratype, Peru, Explorer’s Inn; Peru, Tamshiyacu; (i) *O. concolor*, from left to right under black line: paralectotype, French Guiana, Georgetown; Trinidad, Aripo; (j) *Orthemis coracina*, from left to right under black line: Brazil, Rio Gurupí; Surinam, Sipaliwini; Surinam, Aranavero. Abbreviations: alt: antero-lateral triangular projection; de: paired depression; me: medial excision; mlr: medio-longitudinal ridge; lm: lateral margin; lt: lateral triangular projection; sr: semi-circular rib; tr: transverse ridge; ur: inverted U-shaped ridge.

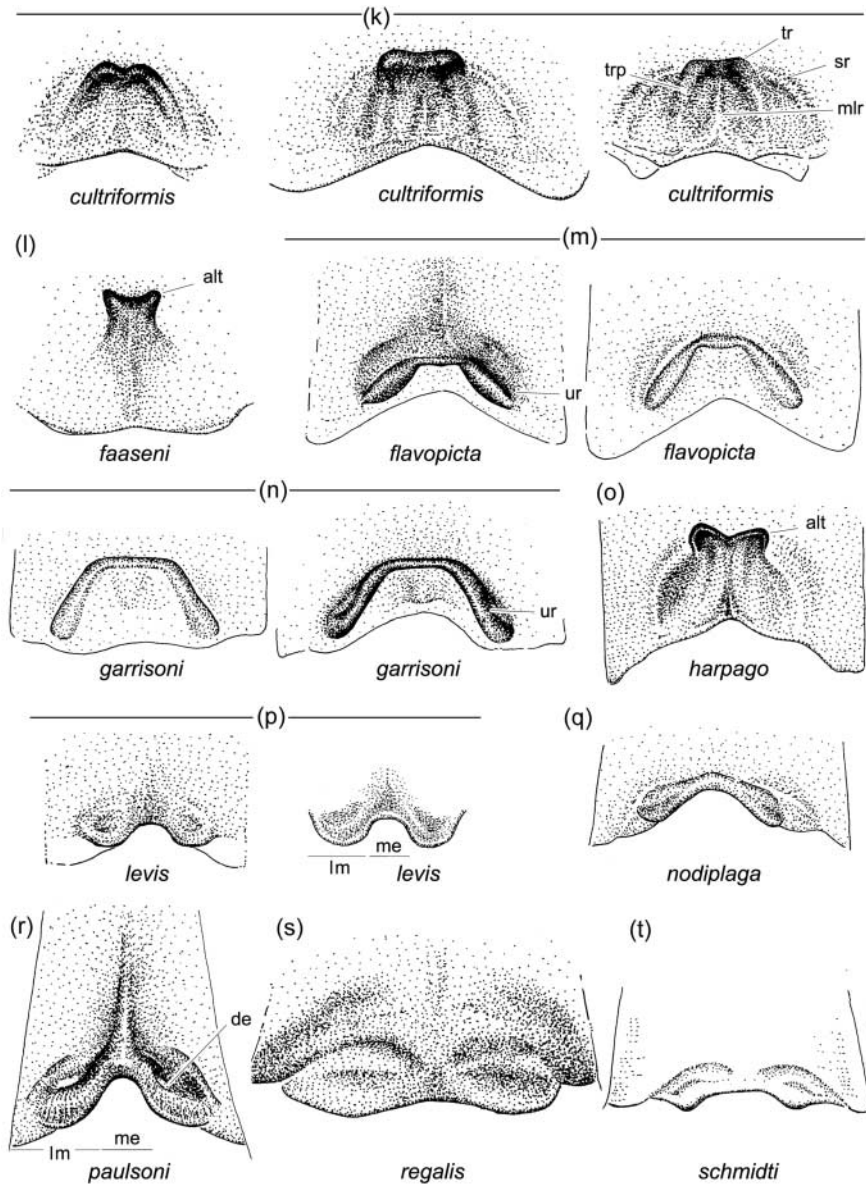


Figure 18. Continued. (k) *O. cultriformis*: from left to right under black line: Peru, Pakitza; Brazil, Cacaullandia; Brazil, Rio Gurupí; (l) *O. faaseni*, paratype, Peru, Tamshiyacu; (m) *O. flavopicta*, from left to right under black line: Brazil, Lauro de Freitas; Brazil, "Pará"; (n) *O. garrisoni*, paratypes, Panama, Gamboa, from left to right under black line: 20 June 1936; 22 May 1937; (o) *O. harpago*, Peru, Aguas Negras; (p) *O. levis*, from left to right under black line: paratype, Guatemala, San José; Venezuela, Carabobo; (q) *O. nodiplaga*, Argentina, N of Santo Tomé; (r) *O. paulsoni*, paratype, Peru, Tambopata; (s) *O. regalis*, Surinam, Brownsweeg; (t) *O. schmidtii*, holotype, redrawn from Buchholz (1950). alt: antero-lateral triangular projection; de: paired depression; me: medial excision; mlr: medio-longitudinal ridge; lm: lateral margin; sr: semi-circular rib; tr: transverse ridge; trp: posterior projection of lateral end of transverse ridge; ur: inverted U-shaped ridge.

and ventral terga, as well as color pattern of the holotype of *O. plaumanni* Buchholz fully agree with those of the holotype of *O. ambinigra* Calvert. The holotype of *O. plaumanni* has two bridge crossveins in both Fw and only one in both Hw. Supernumerary bridge crossveins are common in *O. ambinigra*, with ca. 55% of the examined specimens having them in at least one wing, although

their presence and number are variable and cannot be used as a diagnostic character: ca. 5% of examined specimens have two to three bridge crossveins in three wings, ca. 25% two to three bridge crossveins in two wings, and ca. 25% two bridge crossveins in one wing. Supernumerary bridge crossveins are also found on occasion in other species of *Orthemis*, i.e. I observed them in *O. paulsoni*, *O. philipi*, *O. tambopatae*, and *O. teres*.

Distribution and biology

Orthemis ambinigra ranges from SE Brazil through Uruguay to central Argentina (Figure 22). Adults are found perching and flying along vegetated river margins and temporary ditches and ponds, usually in partially shaded situations.

Orthemis ambirufa Calvert, 1909

Figures 2e, 7c, 8c, 10c, 11c, 12c, 13c, 14c, 15d, 16c, 17c, 18d, 23

Orthemis ambirufa Calvert, 1909, p. 246 (description; holotype male from Chapada, Brazil, in CMNH); Garrison & von Ellenrieder (2004, p. 467, figures 1a–b, 2; synonymy with *O. sibylla*, illustrations of male genital fossa, hamule, pterothorax, and S10); von Ellenrieder (2009, pp. 349, 374, 380, figures 1a, 8b, 9b, 14b, 15b, 19, plate VIIa, table 1; illustrations of hamule, S10, map, inclusion in key, color picture of male).

Orthemis aequilibris nec Calvert, 1909 – Ris (1910, p. 287, figure 162; in part, misidentification).

Orthemis sibylla Ris, 1919, p. 1104 (description; male holotype from Surinam, in IRSNB); Rácenis (1954, p. 2; description of female, illustration of S8–10).

Specimens examined

Total 10 ♂, 6 ♀: 1 ♀, Colombia, Meta Dept., Estrela, La Macarena, Río Guejar (2°11'17" N, 73°47'55" W), 26 January 1972, leg. W. Benson [DRP]; 1 ♂, Venezuela, Bolívar State, Canaima at Río Carrao (6°14'30" N, 62°50'53" W), 12–14 August 1990, leg. RWG [RWG]; 2 ♂, Venezuela, Amazonas State, 2 km E San Carlos de Río Negro (1°58'29" N, 66°57'32" W), 2–5 March 1984, leg. O. Flint Jr. & J. Louton [RWG]; 3 ♂, French Guiana, small canal 17 km S of Tonate (4°51'48" N, 52°28'28" W), 18 February 1998, leg. RWG [RWG]; 1 ♂, French Guiana, Kaw Mountain Reserve, vicinity Amazone Nature Lodge, ca. 15 km SE of Roura (4°33'21" N, 52°11'52" W), 3 October 2010, leg. M.C. Thomas [JJD]; 1 ♀, Ecuador, El Oro Prov., Piedras (3°38' S, 79°55' W), 6 July 1941, leg. D.B. Laddey [UMMZ]; 1 ♂, Brazil, Pará State, Santarem-Amazonas (2°26' S, 54°42' W), December 1920 [UMMZ]; 1 ♀, Brazil, Mato Grosso State, Confluence of Tapirapé and Araguaia rivers, open pasture near village (10°45' S, 50°30' W), 11–30 November 1960, leg. B. Malkin [UMMZ]; 2 ♂, 1 ♀, same but Barra do Tapirapé (14°51' S, 57°45' W), 2/16 January 1966 [MZUSP]; 1 ♀, Bolivia, Beni Dept., Río Benicito, Chacobo Indian Village, forest trail (12°20' S, 66°00' W), 11–27 December 1960, leg. B. Malkin [UMMZ]; 1 ♀, Bolivia, Beni Dept., Riberalta, 25 km S, forest trail (11°13'58" S, 66°09'28' W), 28 October 1972, leg. D.L. Pearson [DRP].

Diagnosis

Male of *O. ambirufa* has reddish to orange-brown frons and vertex lacking metallic reflections, labial palp with medial black stripe as wide as 0.33 or less of palp width, pterothorax reddish brown with yellow stripes (Figure 2e), and dorsal terga of S2–10 red except for ventrolateral and

posterior carinae narrowly black. Abdomen narrows gradually from S2 to S4, and S4 is about as wide at level of apical carina as 0.33–0.55 of its length. Hamule inner and outer branches are located in the same plane (Figure 10c), with both ending at about the same level; inner and outer corners of outer branch are smoothly rounded (Figure 11c). Distal segment of vesica spermalis is ca. rectangular, with sides approximately parallel in ectal view (Figure 13c), with paired distal medial longitudinal membranous lobes beset with denticles along distal margin on ectal side, paired outer lateral lobes about as long as basal sclerotized portion and folded medially to the sides (Figure 12c), and paired flagella. Cercus curves ventrally only slightly and gradually (Figure 15d) and is almost straight and cylindrical in dorsal view (Figure 14c). Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16c). Male of *O. ambirufa* shares combination of a mostly red abdomen gradually narrowing at base, epiproct narrow at apex, and hamule with inner and outer branches in about the same plane only with *O. ambinigra*, *O. tambopatae*, and *O. teres* within the *levis* group. It differs from all of them by the reddish brown frons and vertex lacking metallic reflections (versus metallic purple with blue reflections) and cercus almost straight (Figure 14c) and slanting only slightly (Figure 15d); versus not straight (Figure 14b, o) and curved ventrally (Figures 15v, w).

Female shares with male: labial palp with narrow medial black stripe (0.33 or less of palp width), pterothorax reddish brown with yellow stripes, abdomen narrowing gradually from S2 to S4 (Figures 7c, 8c), and S4 about as wide at level of apical carina as 0.34–0.44 of its length. Color of dorsal terga S2–10 is pale orange to reddish brown, with longitudinal yellow stripes along mediodorsal and ventrolateral carinae (Figures 7c, 8c). Ventrolateral flap on S8 is yellow and relatively narrow, ca. 0.21–0.26 as wide as its length, with a smoothly curved contour (Figure 17c). Sternum S8 is smooth, with vulvar lamina consisting of posterior margin of S8 forming a shallow inverted U-shaped rim, with the medial excision wider than its lateral margins (Figure 18d). *Orthemis attenuata*, *O. concolor*, and *O. levis* also have a smooth sternum S8 with posterior margin of sternum S8 forming an inverted U-shaped rim, but the medial excision is narrower than its sides (Figure 18e, i, p), and their abdomen is much more slender, abruptly narrowed at base (Figures 7e, g, m, 8e, g), while the abdomen is wider and only slightly and gradually narrowed at base in *O. ambirufa* (Figures 7c, 8c).

Distribution and biology

Distribution range extends from Colombia, Venezuela and the Guyanas south to N Bolivia and Brazil (Figure 23). Habitat includes rivers and ditches in forested areas.

Orthemis anthracina De Marmels, 1989

Figures 1c, d, 6c, 7d, 8d, 10d, 11d, 12d, 13d, 14d, 15e, 16d, 17d, 18g, 19c–d, 25

Orthemis anthracina De Marmels, 1989, p. 51, figures 209–214 (description, illustrations of male S10, epiproct, vesica spermalis, genital fossa; holotype from Neblina Base Camp, Upper Río Baría, Río Negro Dept., Amazonas Federal Territory, Venezuela, in MIZA).

Orthemis cultriformis nec Calvert, 1899 – Ris (1919, p. 1104, in part; female from Voorburg; misidentification).

Orthemis flavopicta nec Kirby, 1889 – Belle (2002, p. 5; record from Surinam; misidentification).

Specimens examined

Total 10 ♂, 11 ♀: 1 ♀, Venezuela, Falcón State, Palma Sola (10°36'14" N, 68°32'44" W), 9 March 1920, leg. J.H. & E.B. Williamson & W.H. Ditzler [UMMZ]; 1 ♀, Trinidad, Saint David Parish,

Todds Road (10°28' N, 61°20' W), 9 March 1932, leg. G. Belmontes [UMMZ]; 1 ♀, Colombia, Antioquia Dept., Puerto Berrío (6°30' N, 74°24' W), 31 January 1917, leg. J.H. & E.B. Williamson [UMMZ]; 1 ♀, same but [NE]; 1 ♀, Surinam, Commewijne Dist., Voorburg (5°53' N, 55°5' W), 24 February 1912, leg. E.B. Williamson & B.J. Rainey [UMMZ]; 1 ♂, Surinam, Para Dist., Mapane, forest trail camp 8–12 (5°28' N, 54°41' W), 8/11 December 1953, leg. D.C. Geijskes [RMNH]; 1 ♀, Surinam, Brokopondo Dist., Brokopondo (5°4' N, 54°58' W), 25 December 1968, leg. W.L. & J. G. Peters [FSCA]; 1 ♂ (in copula), Surinam, Brokopondo Dist., Brownsberg (5°1' N, 55°10' W), 2 March 1959, leg. D.C. Geijskes [RMNH]; 1 ♂, Surinam, Sipaliwini Dist., Kabalebo, Aranavero (4°25' N, 57°13' W), 10 April 1971, leg. D.C. Geijskes [RMNH]; 2 ♂, Surinam, Sipaliwini Dist., Toekoemoetoe, Tafelberg transect km 1–3, 3.7 (3°47'30" N, 56°11'44" W), 11/14 September 1944, leg. L. Schmidt [RMNH]; 3 ♂, Surinam, Sipaliwini Dist., Sipaliwini, small stream near airstrip (2°6' N, 56°2' W), 14/17 February 1961, leg. D.C. Geijskes [RMNH]; 1 ♂, Surinam, Sipaliwini Dist., Werehpai (2°21'46" N, 56°41'53" W), forest creek, 05 September 2010, leg. NE [NE]; 2 ♀, Peru, Loreto Dept., Explorama Lodge, 50 mi NE Iquitos on Amazon River at junction with Yanamono River (3°21'59" S, 72°47'56" W), 14 August 1989, leg. S.W. Dunkle [RWG]; 1 ♀, Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, Río Blanco, small mixed water river, near main lodge (4°19'33" S, 73°13'29" W), 10 August 2009, leg. TF [TF]; 1 ♀, same but Dolfin Lake, small black water lake within primary restinga forest with a direct connection to Río Tahuayo (4°22'33" S, 73°15'21" W), 2 August 2009, leg. TF [TF]; 1 ♂, 1 ♀ (in copula), Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, at light gap on muddy site near a small black water stream within an area of scrubby lower restinga (4°23'43" S, 73°15'40" W), 30 July 2009, leg. TF [TF].

Description of female

Head. Labium black, with palps pale yellow with medial black stripe as wide as 0.33–0.40 of palp width and anterior margin narrowly black (Figure 1d); labrum black with pair of yellow laterobasal spots; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, remainder of clypeus pale brown; ventral half of antefrons pale brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex pale to dark reddish brown, with medial furrow of postfrons and vertex around ocelli with metallic reflections in some females; occipital triangle pale to dark reddish brown with yellow posterior surface, rear of head reddish brown with two yellow spots behind eyes. Postfrons with wide shallow medial furrow; vertex with a pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown except anterior lobe, mediodorsal area of middle lobe, and posterior margin of posterior lobe yellow. Pterothorax (Figure 19d) reddish brown with pale yellow stripes as follows: mesepisternum with medial longitudinal stripe adjacent to mediodorsal carina, longitudinal stripe parallel to mesepisternal–mesepimeral carina, and narrow stripe along medial third of mesepisternal–mesepimeral carina; mesepimeron with wide stripe along posterior half narrowing dorsally; metepisternum with narrow stripe along ventral margin and another sinuous one ventral to metastigma; metepimeron with a stripe along posterior half, narrowing dorsally, and subtriangular spot on anterodorsal corner; venter of pterothorax pale yellow with lateral margins from base of leg to posterior margin reddish brown. – Posterior surface of coxa, trochanter, and femur of front leg and posterior surface of coxa of middle and hind leg pale yellow, remainder dark reddish brown; tibia, tarsus, pretarsus, and spination black; metafemur armed with 14–22 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings entirely infumated in 45% of the females, to hyaline with restricted amber areas, from base to level of first row of anal cells in FW and to third row in HW, and apex across distal three rows to distal end of pt. One cubito-anal crossvein and arculus between to Anx 2 and

Anx 3, usually closer to Anx 2, sometimes midway, rarely opposite to Anx 2; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 cells, rarely with 5 cells; one bridge crossvein; Fw discoidal field with 3 rows of cells at base to 4–6 rows at hind margin, Hw with 2–3 at base, then 2, then increasing to 12–16 at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 19–25 cells. Pt orange to reddish brown, overlying 4–6 cells. Anx: 16–20 in Fw, 13–15 in Hw; Pnx: 13–17 in Fw, 13–17 in Hw.

Abdomen. Sides linear, gradually narrowing from S3 to S4 in ventral view (Figure 6c), S4 ca. twice as long as wide (ratio apical width/length = 0.39–0.57). Dorsal terga (Figures 7c, 19d) with mid-dorsal carina bordered by yellow on S1–3 to S4, and by pale orange in S4 or S5–7; S1–3 to S5 pale reddish brown with ventral third yellow; S4 to S6–7 pale orange red with medial third diffusely brown; S8 dark reddish brown to black with ventrolateral flap whitish; S9–10 and caudal appendages dark reddish brown to black. Ventrolateral carina on S2 vestigial, on S3–7 well developed and black. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 6c) reddish brown with yellow stripe along ventrolateral carinae on S1–6, orange in S7; S8 whitish to pale yellow; S9–10 dark reddish brown. Ventrolateral flap on S8 is yellow (Figure 17d), and ca. 0.2–0.28 as wide as long. Vulvar lamina on S8 consisting of a medial longitudinal ridge extending along posterior 0.20 of S8 length, bordered lateroanteriorly by semicircular ribs, with anterior transverse ridge with its sides projected laterally into triangular, concave points (Figure 18g).

Dimensions ($n = 10$). Total length 44.2–49 [46.55 \pm 1.45]; abdomen length 29–32.5 [30.74 \pm 1.09]; Fw length 36.4–39.2 [38.02 \pm 0.88]; Hw length 35–37.8 [36.62 \pm 0.95]; maximum Hw width 9.6–10.8 [10.16 \pm 0.34]; Fw Pt length 4.2–4.8 [4.49 \pm 0.19]; Hw Pt 4–4.6 [4.32 \pm 0.20]; S4 ratio apical width/length 0.39–0.57 [0.495 \pm 0.05]; ventrolateral flap on S8 length 2.8–3.2 [3.03 \pm 0.11], width 0.6–0.9 [0.77 \pm 0.09]; ratio width/length 0.2–0.28 [0.25 \pm 0.03]; cercus length 1.25–1.4 [1.32 \pm 0.05], epiproct length 0.55–0.7 [0.6 \pm 0.05].

Variation in males

Head. As for female but labial palp with medial black stripe as wide as about 0.4–0.5 of palp width (Figure 1c); labrum as in females in teneral specimens black; clypeus and basal portion of antefrons pale to dark reddish brown to black medially; dorsal portion of antefrons, postfrons, and vertex metallic purple with blue; occipital triangle pale reddish brown to dark reddish brown to black.

Thorax. Prothorax as for female to dark reddish brown to black. Pterothorax as in female in teneral males, dark reddish brown with yellow diffuse stripes, to black on mesepisternum with very faint yellowish stripes on metepimeron and metepisternum (Figure 19c) to almost entirely black with metallic blue reflections and brown dashes along mid-dorsal carina and proximal third of mesepisternum (De Marmels, 1989). Venter of pterothorax as in female or black with central area brown. – Legs as in female or black with lateral and extensor surfaces of procoxa and protrochanter pale brown; metafemur armed with 18–35 short spurs, usually followed by 1 longer spur, rarely by two. – Anal loop enclosing 18–23 cells. Pt pale to dark reddish brown. Fw Anx: 16–19; Hw Anx: 12–16; Fw Pnx: 14–17; Hw Pnx: 13–19.

Abdomen. As for female but S4 longer than three times its apical width (ratio apical width/length = 0.21–0.31). Dorsal terga S1–9 mostly red with posterodorsal faint black spot

and S10 black with red mid-dorsal spot, to red with black posterodorsal spot extending to posterior margin on S3–7 or along most of S5–7 and S8–9 black with ventrolateral red stripe, to abdomen almost entirely black; caudal appendages black. Ventrolateral carina on S2 vestigial, on S3–8 well developed and black, on S9 well developed along basal two thirds, absent at distal third. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 6c): mostly

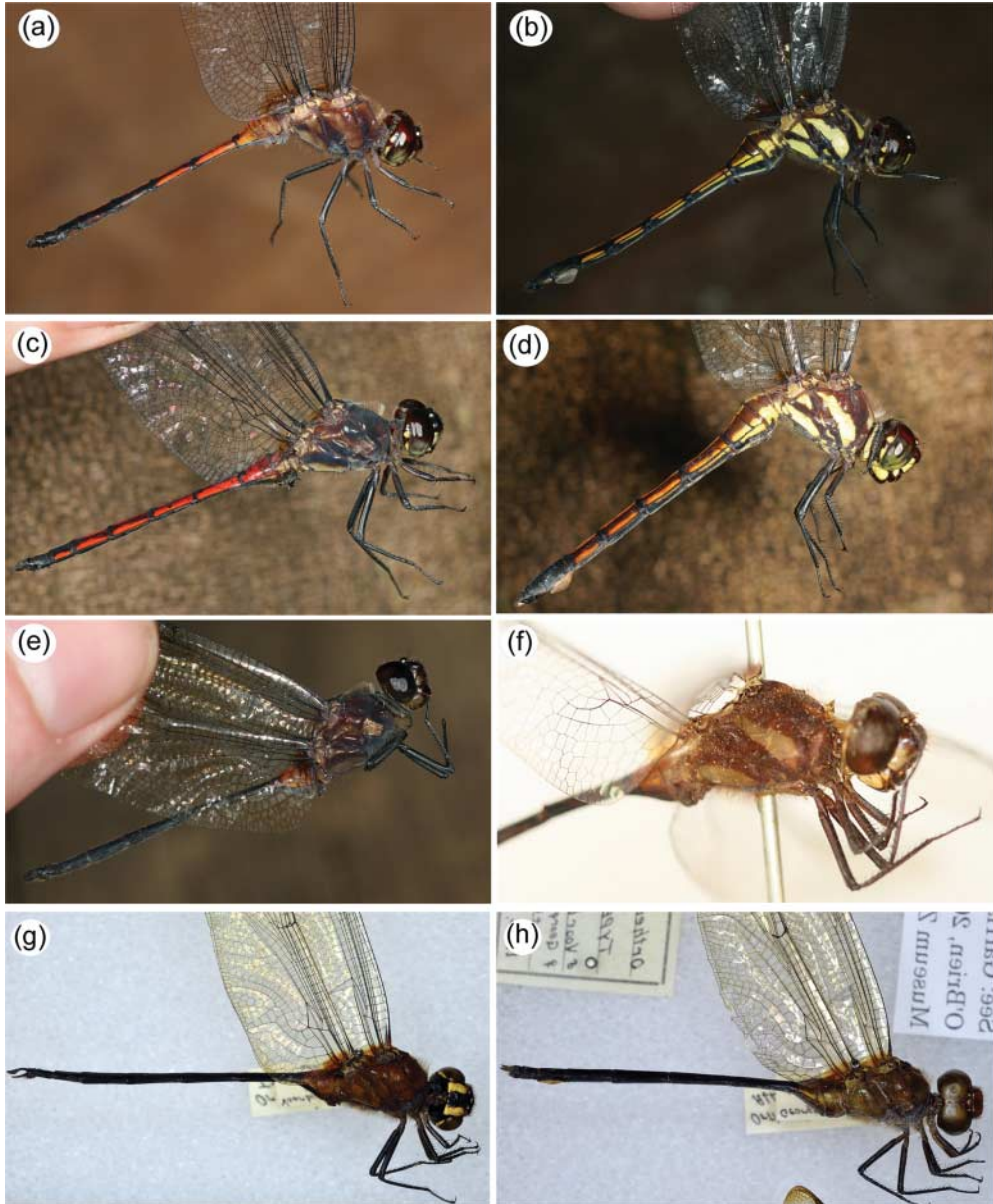


Figure 19. Adult *Orthemis* – (a) *O. aciculata*, male paratype, Peru, Tamshiyacu, 11 August 2009 [RMNH]; (b) *O. cinamomea*, female, Peru, Tamshiyacu, 25 February 2010 [RMNH]; (c) *O. anthracina*, male, Peru, Tamshiyacu, 30 July 2009 [RMNH]; (d) *O. anthracina*, female, Peru, Tamshiyacu, 30 July 2009 [RMNH]; (e) *O. attenuata*, male, Peru, Tamshiyacu, 18 February 2010 [RMNH]; (f) *O. attenuata*, holotype male [ZMHB]; (g) *O. concolor*, paralectotype male, Surinam, Voorburg [UMMZ]; (h) *O. concolor*, paralectotype female, Surinam, Voorburg [UMMZ]. Photographed by: (a–e) T. Faasen; (f) M. Turiault; (g–h) M. O'Brian.



Figure 19. Continued. (i) *O. coracina*, male, Peru, Tamshiyacu, 10 August 2009 [RMNH]; (j) *O. coracina*, male, Peru, Tamshiyacu, 31 July 2009 [RMNH]; (k) *O. faaseni*, paratype male, Peru, Tamshiyacu [RMNH]; (l) *O. faaseni*, paratype female, Peru, Tamshiyacu [RMNH]; (m) *O. flavopicta*, male, Brazil, Lauro de Freitas, 16 February 2012; Brazil; (n) *O. flavopicta*, female, Brazil, Lauro de Freitas, 18 June 2005; (o) *O. garrisoni* male, Panama, Panamá province, Plantation Trail near Canopy Tower, 9 November 2011; (p) *O. paulsoni* male, Peru, Madre de Dios Department, Manu National Park, November 2010. Photographed by: (i–l) T. Faasen; (m–n) R. Penalva, not collected; (o) D. Smallshire, not collected; (p) R. Williams, not collected.

black to dark reddish brown or black with yellow stripe along ventrolateral carinae on S1–7; S8–10 dark reddish brown to black. Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Figure 10d); hamule bifid with small inner branch forming short pointed spine, and larger outer branch bent ventrally over inner branch with blunt square tip; outer corner of outer branch rounded (Figure 11d). Distal segment of vesica spermalis with basal portion trapezoidal

in ectal view (Figure 13d), and with long flagella on ental surface; distal lobes represented on each side by medial longitudinal semicircular membranous lobe with sclerotized lateral projection margined with denticles, and elongate rhomboidal outer lobe longer than basal portion of distal segment in lateral view (Figure 12d). Cercus markedly curved ventrally in lateral view, with tip upturned, with a row of 4–6 tubercles along distal dilated portion (Figure 15e); in dorsal view converging along basal 0.70 with opposite cercus, then approximately parallel to it along distal 0.30 (Figure 14d). Epiproct extending to 0.65–0.74 of cerci length, as long as 0.77–0.84 of its maximum width, with apex bifid and as wide as 0.72–0.80 of its maximum width (Figure 16d).

Dimensions ($n = 10$). Male total length 43.7–49 [45.97 ± 1.78]; abdomen length 28.3–32 (holotype 28, De Marmels 1989) [29.53 ± 1.31]; Fw length 35.2–40 [37.37 ± 1.29]; Hw length 34.2–37.5 (holotype 32.5, De Marmels 1989) [36.00 ± 1.19]; maximum Hw width 9.6–10.7 [10.14 ± 0.32]; Fw Pt length 4.2–4.6 (holotype 4, De Marmels 1989) [4.39 ± 0.15]; Hw Pt 4–4.3 [4.16 ± 0.14]; S4 ratio apical width/ length 0.21–0.31 [0.26 ± 0.03]; cercus length 1.85–2.05 (holotype 2, De Marmels 1989) [1.96 ± 0.06]; epiproct length 1.25–1.45 [1.34 ± 0.06]; epiproct maximum width 1.05–1.115 [1.09 ± 0.03]; epiproct subapical width 0.80–0.85 [0.82 ± 0.02].

Diagnosis

Male of *O. anthracina* shares apex of epiproct wide, ca. 0.50 of epiproct maximum width or wider, and bifid, with only *O. aciculata*, *O. celata*, *O. cinnamomea*, *O. coracina*, and *O. harpago*. It differs from all of them by the extremely wide epiproct apex, 0.80–0.85 mm measured subapically (Figure 16d; versus as wide as 0.55–0.70 mm measured subapically, Figure 16a, f, h, j, o), and by vesica spermalis distal segment with paired sclerotized projections on medioectal lobes, which are triangular in ectal view (Figure 13d; versus absent or not triangular, Figure 13a, f, g–h, m). It further differs from *O. cinnamomea* by frons and vertex metallic purple with blue reflections (versus reddish brown) and from all others by hamule shape (Figure 11d); from *O. aciculata* by tip of inner branch almost touching tip of outer branch (versus separated by distance of ca. twice inner branch length, Figure 11a), from *O. celata* by inner branch visible in frontal view (versus appressed against outer branch medial surface and hidden from view, Figure 11f), from *O. coracina* by outer corner of outer branch smoothly rounded in frontal view (versus roundly angled, Figure 11k), and from *O. harpago* by inner branch shorter than outer branch (versus longer than outer branch, Figure 11m).

Female shares a similar vulvar lamina, characterized by the presence of a medial longitudinal ridge anterior to posterior margin of sternum S8, usually enclosed by anterolateral semicircular ribs, with *O. aciculata*, *O. cinnamomea*, *O. coracina*, *O. cultriformis*, *O. faaseni*, and *O. harpago*. However, only in *O. anthracina* are the anterolateral sides of the anterior transverse ridge projected laterally as triangular concave points (Figure 18g); there are triangular projections also in *O. cinnamomea*, *O. coracina*, *O. faaseni*, and *O. harpago* but these are directed anterolaterally, not laterally (Figure 18h–j, l–o). It further differs from *O. cinnamomea* and *O. harpago* by abdomen narrowing gradually at base (Figure 7d, versus more abruptly, Figure 7f, l), from *O. aciculata*, *O. cinnamomea*, and *O. cultriformis*, by a relatively narrower flap on S8, with a ratio width/length of 0.20–0.28 (Figure 17d, versus ratio width/length of 0.30–0.36, Figure 17a, f, j), and from *O. faaseni* by a longer S4 (Figure 8d, 4.8–5.3 mm, versus 4.3 mm, Figure 8i) and S8 flap whitish (Figure 19d, versus reddish brown, Figure 19i).

Remarks

At the time of my previous analysis of the *levis* group of *Orthemis* (von Ellenrieder, 2009), I had only one male from Panama [RWG] identified as *O. anthracina* available for study. More

recent examination of a relatively large series of specimens from the lowland Amazon forest from Peru, Surinam, and Brazil fitting closely the description of *O. anthracina* and differing from the male from Panama in morphology of vesica spermalis and hamule allowed me to conclude that the male studied previously was misidentified, representing the species I describe here as *O. aciculata*. Several of the specimens of *O. anthracina* found in collections were misidentified as *O. cultriformis* [UMMZ] and *O. flavopicta* [RMNH].

Distribution and biology

Orthemis anthracina is known from Venezuela and Trinidad south through Surinam and N Peru (Figure 25). Habitats include forested creeks, streams, rivers, and lakes.

Orthemis attenuata (Erichson, 1848)

Figures 7e, 8e, 9b, 10e, 11e, 12e, 13e, 15f, 16e, 17e, 18e, 19e–f, 24

Libellula attenuata Erichson, 1848, p. 583 (description; holotype from British Guiana, in ZMHB).

Neocysta attenuata (Eversmann, 1848) – Kirby (1889, p. 301; mistakenly assigned name authorship to Eversmann).

Neocysta attenuata (Erichson, 1848) – Kirby (1890, p. 35; corrected name authorship to Erichson).

Orthemis attenuata (Erichson, 1848) – Ris (1904, p. 43; revised generic placement); Calvert (1906, pp. 232, 234; inclusion in key); Ris (1910, pp. 281, 292, in part; inclusion in key, redescription); Ris (1919, p. 1105; diagnosis from *O. concolor*); von Ellenrieder (2009, pp. 349, 374, 378, 6e, 8d, 9d, 14d, 15d, 16c, 18b, 19, table 1; inclusion in key, illustrations of S4, hamule, female S8 flap, and vulvar lamina, map).

Specimens examined

Total 44 ♂, 4 ♀: 19 ♂, 1 ♀, Colombia, Antioquia Dept., Puerto Berrío (6°30' N, 74°24' W), 31 January/21 February 1917, leg. J.H. & E.B. Williamson [UMMZ]; 1 ♂, same but Cristalina (6°29' N, 74°50' W), 20 February 1917 [UMMZ]; 1 ♂, Colombia, Boyacá Dept., Sogamoso (5°43'14" N, 75°55'47" W), 29 January 1917 [UMMZ]; 1 ♂, 1 ♀, Colombia, Magdalena Dept., Fundación (10°31'17" S, 74°11'12" W), 13 January 1917, leg. J.H. & E.B. Williamson [RWG]; 4 ♂, same but 14 January 1917 [UMMZ]; 1 ♂, Venezuela, Delta Amacuro State, Río Grande Research Station, 26 km E of El Palmar, rain forest (8°2'58" N, 61°38'00" W), 25 March 1978, leg. J.B. Heppner [FSCA]; 1 ♂, Venezuela, Barinas State, San Silvestre (8°16'47" N, 70°6'30" W), 20 December 1957, leg. J. Rácenis [FSCA]; 1 ♂, same but 23 December 1957 [RWG]; 1 ♂, Venezuela, Bolívar State, 80 km S of El Dorado (6°10'57" N, 61°25'10" W), 26 June 1984, leg. J. Nation [FSCA]; 1 ♂, Guyana, Upper Demerara-Berbice Region, Rockstone, 12 February 1912, leg. L.A. & E.B. Williamson & B.J. Rainey [FSCA]; 2 ♂, Brazil, Rondônia State, Rio Pardo and tributaries, ca. 13 km NW of Fazenda Rancho Grande (62 km SW of Ariquemes) (10°25'48" S, 62°51'36" W), 5–10 November 1989, leg. RWG [RWG]; 1 ♂, same but stream about 7 km SE of Cacauplandia, about 70 km SW of Ariquemes (10°31'48" S, 62°48'00" W); 1 ♀, same but 21 November 1991, leg. M.J. Westfall Jr. [FSCA]; 1 ♂, Brazil, Acre State, Monte Rico, Sena Madureira, Rio Macaia (9°4' S, 68°40' W), 5 November 2007, leg. J.L. Nessimian [DZRJ]; 1 ♂, Brazil, Pará State, Rio Iriri Camp, ca. 100 km S of Altamira (3°50' S, 52°40' W), 17 October 1986, leg. P. Spangler & O.S. Flint Jr. [RWG]; 1 ♂, 1 ♀, Brazil, Pará State, Rio Xingu Camp, ca. 60 km S of Altamira, Igarapi, N of Camp, trail of forest (3°39' S, 52°22' W), 10–11 October 1986, leg. P. Spangler &

O.S. Flint Jr. [RWG]; 1 ♂, Brazil, Pará State, Floresta Nacional de Carajás, Parauapebas, km 47 estrada para Serra Sul (6°8'45" S, 50°8'38" W), September 2006, leg. N. Ferreira Jr. & L.L. Dumas [DZRJ]; 1 ♂, Brazil, Bahia State, Parque Encontro das Aguas (12°51'47" S, 38°18'50" W), 22 October 2011, leg. Ruy Penalva [NE]; 1 ♂, Brazil, Mato Grosso State, Rio Pindaíba, Fazenda Canaa, RIP, Nova Xavantina/Araguaiana (14°58' S, 52°18' W), 2 October 2005, leg. J.D. Batista & L.A. Castro [DZRJ]; 1 ♂, Brazil, Espírito Santo State, Ribeirão do Engano, Vale do Itauna (20°37' S, 40°51' W), leg. Travassos & Santos [UMMZ]; 1 ♀, Peru, Loreto Dept., Iquitos (3°46' S, 73°15' W), leg. P. Naguel [UMMZ]; 2 ♂, Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, Río Blanco, pH of 6.3 and EC of 19 μ S/cm (4°19'38" S, 73°13'29" W), 18 October 2010, leg. TF [TF]; 1 ♂, Bolivia, Santa Cruz Dept., Ñuflo de Chávez Province, San Ramón, 11 km E on road to San Luis Herman, small roadside pond (16°38'43" S, 62°30'32" W), 15 November 1998, leg. W. Mauffray [FSCA].

Diagnosis

Male of *O. attenuata* has metallic purple frons and vertex, labial palp with medial black stripe as wide as 0.33–0.40 of palp width, pterothorax reddish brown with yellow stripes (Figure 19f), which can be obscured in mature males (Figure 19e), dorsal terga of S1–3 mostly reddish brown to orange, and S4–10 mostly black with narrow yellow to orange stripes along S4–7 medial longitudinal carinae and along S4–5 to S4–8 ventrolateral carinae. Abdomen narrows abruptly from S2 to S4 (Figures 19e–f), and S4 is about as wide at level of apical carina as 0.22–0.33 of its length. Hamule inner and outer branches are located in the same plane, with both ending at about the same level (Figures 9b, 10e); inner corner of outer branch is smoothly rounded (Figure 11e). Distal segment of vesica spermalis is ca. oval, with sides gradually converging to distal end in ectal view (Figure 13e), paired distal short medial longitudinal membranous lobes beset with denticles along distal margin on ectal side, paired outer lateral lobes shorter than basal sclerotized portion of distal segment, folded medially to the sides (Figure 12e), and paired flagella. Cercus gradually curves ventrally (Figure 15f) and its tip is slightly upturned. Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16e).

Male of *O. attenuata* shares the combination of an abruptly narrowed abdomen at base and epiproct tip narrow and entire only with *O. concolor* and *O. levis*. These three species are morphologically very similar, differing almost solely by color pattern. *Orthemis attenuata* differs from *O. concolor* by its metallic purple frons and vertex, in teneral males reddish brown with some metallic purple reflections on medial furrow of frons and around ocelli, and by the pterothorax with yellow stripes, which can be obscured in mature males; versus frons and vertex reddish brown and pterothorax concolorous reddish brown (Figure 19g–h), sometimes with ill-defined diffuse yellow areas on mesepisternum, more extensive in teneral males. *Orthemis attenuata* can be distinguished from *O. levis* by its abdominal color pattern, with S1–3, or S1–4 in teneral males, mostly reddish brown to orange, and S4–10 mostly black with only narrow yellow to orange medial longitudinal stripes on S4–7 and ventrolateral stripes on S4–5 to S4–8 (versus abdomen mostly red, with only S8–10 dorsally black in *O. levis*), and by shape of abdomen base between apex of S2 and base of S3, which is more markedly globose in *O. attenuata* (Figures 19e–f) than it is in *O. levis* (as in Figure 7m).

Female shares with male: labial palp with narrow medial black stripe (0.33–0.40 of palp width), pterothorax reddish brown with yellow stripes, and slender abdomen narrowing abruptly from S2 to S4 (Figures 7e, 8e). In some females there are metallic reflections on medial furrow of frons and on vertex surrounding ocelli. Color of dorsal abdominal terga is similar to that of male. Ventrolateral flap on S8 is yellow and relatively narrow, ca. 0.23–0.26 as wide as its length, with a smoothly curved contour (Figure 17e). Sternum S8 is smooth, with vulvar lamina consisting of

posterior margin of S8 forming a shallow inverted U-shaped rim, with medial excision narrower than its lateral margins (Figure 18e).

Combination of relatively slender abdomen narrowing abruptly at base, with base of S4 less than half as high as base of S3 in lateral view (Figure 7e), and vulvar lamina consisting of shallow inverted U-shaped rim of S8 posterior margin is shared only with *O. concolor* and *O. levis*. *Orthemis attenuata* differs from *O. concolor* by its pterothorax with yellow stripes (as Figure 19f), versus pterothorax concolorous reddish brown (Figure 19h) with variable extent of ill-defined diffuse yellow areas on mesepisternum in teneral females, and by the position of the paired depressions anterior to vulvar lamina rim, which in *O. attenuata* are located directly anterior to the lateral margins of the medial excision of the rim (Figure 18e), whereas in *O. concolor* they are located laterally to the medial excision (Figure 18i). Differentiation of the female from that of *O. levis* is based on shape of abdomen base between apex of S2 and base of S3, which is more markedly globose in *O. attenuata* (Figure 7e) than in *O. levis* (Figure 7m). As in the male, female of *O. attenuata* also differs by dorsal terga S4–7 mostly dark reddish brown to black with narrow mediodorsal and ventrolateral pale stripes versus mostly red in *O. levis*. Red color on abdominal dorsal terga S4–7 in females of *O. levis* is not as pronounced as it is in males, being sometimes replaced by reddish brown, and unlike in males, in females of *O. levis* there are yellow to orange pale stripes along mediodorsal and ventrolateral carinae of S1–7 to S1–8, so that abdominal color of poorly preserved females can look very similar to that of females of *O. attenuata*.

Remarks

Ris (1919, p. 1105) indicated that Dr. Grünberg was unable to find the type of this species in the collection of the Berlin Museum [ZMHB]. However, Michael Ohl, current curator at that institution, confirmed that the holotype is in fact hosted there, and Mélanie Turriault kindly photographed it (Figure 19f), allowing for confirmation of the correct association of this name by Ris and further workers.

Distribution and biology

Extends from Colombia, Venezuela, and Guyana south to Peru, Bolivia, and Brazil (Figure 24). Habitat includes rivers, streams, and ponds in forested areas.

Orthemis celata sp. nov.

Figures 1e, 2f, 4b, 5b, 6d, 9c, 10f, 11f, 12f, 13f, 14e, 15f, 16f, 23

Etymology

From Latin *celata* (concealed), the female gender of the adjective *celatus*, referring to the position of hamule inner branch, concealed from sight in lateral view.

Type specimens examined

Total 1 ♂. – Holotype ♂: Brazil, Pará State, Rio Gurupí, Canindé (0°30'57" S, 51°14'00" W, 9 m), 27–28 February 1966, leg. B. Malkin [RMNH].

Male holotype

Head. Labium black, with palps pale yellow with medial black stripe as wide as 0.40 of palp width and anterior margin narrowly black (Figure 1e); labrum black with pair of rounded laterobasal pale yellow spots; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, remainder of anteclypeus pale brown, postclypeus pale brown with medial dark brown spot and postclypeal lobes narrowly fringed with dark brown line along distal margin; ventral half of antefrons pale brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex metallic purple with blue reflections, occipital triangle dark reddish brown, rear of head reddish brown. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown. Pterothorax (Figure 2f) reddish brown with pale yellow stripes as follows: wide stripe along posterior half of mesepimeron narrowing dorsally; metepisternum with narrow stripe along ventral margin and another sinuous one ventral to metastigma, and oval spot on posterodorsal corner; metepimeron with stripe along posterior half, narrowing dorsally, and subtriangular spot on anterodorsal corner; venter of pterothorax pale yellow with triangular reddish brown spot on each side extending from base of leg and narrowing to posterior margin. – Legs with coxa, trochanter, and base of femur reddish brown; femur and tibia dark reddish brown; tarsus, pretarsus, and spination black; metafemur armed with 25 (right) to 27 (left) short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings infumated with small amber spots at base extending to level of first row of anal cells in FW and HW, very narrow reddish tinge around FW nodus, and distal amber spot extending from level of distal end of pterostigma to apex. One cubito-anal crossvein and arculus distal to Anx 2 in Fw and HW; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 (right) to 6 (left) cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 4 (right) or 5 (left) rows at hind margin, Hw with 3 at base, then 2, then increasing to 16 (right) or 13 (left) at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 22 cells. Pt reddish brown, 4.6 (right) and 4.65 (left) long in Fw and 4.5 (right) and 4.35 (left) in Hw, overlying 6 cells in Fw and 5–6 cells in Hw. Anx: 16 in Fw; 13 in Hw; Pnx: 13 (right) and 14 (left) in Fw; 14 in Hw.

Abdomen. Sides linear, gradually narrowing from S3 to S4 in ventral view (Figure 6d), S4 less than three times as long as wide (ratio width/length = 0.38). Dorsal terga (Figure 5b) with mid-dorsal carina narrowly pale yellow in all segments; S1 dark reddish brown; S2–3 orange red; S4–7 mostly orange red, except for small oval posterodorsal faint black spot on posterior 0.15 of segment; S8 orange red with pair of small rounded black spots at mid-length, and dark diffuse mid-dorsal stripe; S9 dark reddish brown; S10 black; caudal appendages dark reddish brown. Ventrolateral carina on S2 vestigial, on S3–8 well developed and black, on S9 well developed along basal two thirds, absent at distal third. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 6d): S1 and S2 dark reddish brown with yellow along ventrolateral carinae; S3–7 dark reddish brown with reddish stripe along lateral margin on basal two thirds of segment; S8 dark reddish brown with reddish stripe along lateral margin on basal half of segment; S9–10 dark reddish brown. Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Figure 10f); hamule bifid with small inner branch forming short pointed spine, parallel to larger outer branch, directed anteriorly (Figure 9c), and not visible in lateral or frontal views of hamule (Figures 10f, 11f); outer branch tip bent ventrally at right angle in lateral view, separated from inner branch by a distance shorter than inner branch length (Figure 9c); outer corner of hamule smoothly curved (Figure 10f). Distal segment of vesica spermalis with basal portion trapezoidal in ventral view (Figure 13f), and with a pair of long flagella on ental surface; distal

lobes represented on each side by an elongate outer oval-shaped lobe ca. as long as basal portion of distal segment in lateral view, and medioectal sclerotized lobe margined with denticles distally and lacking any lateral sclerotized projections; medioectal lobe distinctly shorter than outer lobe (Figure 12f). Cercus markedly curved ventrally in lateral view, with row of 6 ventral tubercles along distal half and upturned tip (Figure 15h); in dorsal view converging along basal 0.66 with opposite cercus, then approximately parallel to it along distal 0.33 (Figure 14e). Epiproct extending to 0.75 of cerci length, with apex bifid and about as wide as 0.73 of its basal width (Figure 16f).

Dimensions. Total length 46.5; abdomen length 29.2; Fw length 37.6; Hw length 36.9; Hw maximum width 10.3; cercus length 1.85; epiproct length 1.38; epiproct maximum width 0.95; epiproct subapical width 0.7.

Diagnosis

Male of *O. celata* shares apex of epiproct wide, ca. 0.50 of epiproct maximum width or wider, and bifid with *O. aciculata*, *O. anthracina*, *O. cinnamomea*, *O. coracina*, and *O. harpago*. It differs from all of them by hamule inner branch appressed against medial surface of outer branch and hidden from view (Figure 11f; versus visible in frontal view, Figure 11a, d, h, k, m) and by paired medioectal lobes of vesica spermalis distal segment almost entirely membranous, with only some marginal denticles along distal margin (Figures 12f, 13f; versus with some kind of lateral sclerotized projection, Figures 12a, d, j, m, 13a, d, g–h, m). It further differs from *O. anthracina* by its narrower epiproct apex, 0.70 mm measured subapically (Figure 16f; versus 0.80–0.85 mm measured subapically, Figure 16d), from *O. cinnamomea* by frons and vertex metallic purple with blue reflections (versus reddish brown), and from *O. harpago* by abdomen gradually narrowed at base in lateral view and dorsal terga of S1–7 mostly red (Figures 4b, 5b; versus constricted abruptly and dorsal terga S1–7 mostly black in mature males, with mediodorsal yellow stripe, Figure 4i).

Female unknown.

Remarks

The holotype male of *O. celata* in the collection of Naturalis Leiden [RMNH] was identified as *Orthemis flavopicta* by Geijskes' in 1970.

Distribution and biology

According to its collection label, the only known male of this species was found at a river in Pará State, Brazil (Figure 23). No information on its preferred habitat or biology is available.

Orthemis cinnamomea von Ellenrieder, 2009

Figures 2g–h, 4c, 7f, 8f, 10g, 11h, 12g, 13g, 14f, 15i, 16g–h, 17f, 18h, 19b, 23

Orthemis cinnamomea von Ellenrieder, 2009 (pp. 352, 374, 378, figures 2b–c, 4a, 8e, 9e, 11b, 12a, 13a, 14e, 15e, 16, 17e, 18c, 19b, 21, plate VIIb, table 1; description, inclusion in key, illustrations of pterothorax, male S1–10, female S8–10, hamule, vesica spermalis, S10, female S8 flap, and vulvar lamina, map, color picture of male; holotype male from Explorer's Inn on Río Tambopata, Madre de Dios Dept., Peru, in USNM).

Orthemis concolor nec Ris, 1919 – Paulson (1985, p. 13; misidentification).

Specimens examined

Total 3 ♂, 5 ♀: 1 ♂ Paratype, Ecuador, Sucumbíos Prov., Limoncocha, lake edge (0°24'0" S 76°36'0" W), 20 February 1972, leg. D.L. Pearson [RWG]; 1 ♀, Ecuador, Orellana Prov., Tiputini Biodiversity Station, near Yasuni National Park, canopy fogging project, Lot# 2109, TR1 #10, terra firme forest (0°37'55" S, 76°08'39" W), 21 October 1999, leg. T.L. Erwin et al. [USNM]; 1 ♂, 1 ♀, Ecuador, Orellana Prov., Reserva Étnica Waorani, 1 km S Okone Gare Camp, canopy fogging project, Lot #973 TR1 #4/Lot #1028, TR4#9, terra firme forest (0°39'25" S, 76°27'10" W), 9/11 February 1995, leg. T.L. Erwin et al. [USNM]; 1 ♀, Peru, Loreto Dept., Río Napo near Ecuador (1°42'53" S, 75°35'7" W), 15 June 1920, leg. H.S. Parish [UMMZ]; 1 ♀ paratype, Peru, Madre de Dios Dept., Explorer's Inn on Río Tambopata, 30 km SW Puerto Maldonado, main trail (12°50'18" S, 69°17'59" W), 20 August 1978, leg. Paul K. Donahue [RWG]; 1 ♂, Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, Río Tahuayo upstream from research centre (4°23'32" S, 73°15'46" W), 22 February 2010, leg. TF [TF]; 1 ♀, Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, aguajal behind research grid (4°24'18" S, 73°14'38" W), 25 February 2010, leg. TF [TF].

Diagnosis

Male of *O. cinnamomea* has pale to dark reddish brown frons and vertex, labial palp with medial black stripe as wide as ca. 0.33 of palp width, pterothorax reddish brown with pale yellow stripes, dorsal terga mostly reddish brown, with ventrolateral margins of S1–3 pale greenish-yellow, and narrow longitudinal orange stripes mediodorsally on S1–7 and both dorsal and ventral to ventrolateral carinae on S3–7 (Figure 4c). Abdomen narrows abruptly from S2 to S4 (Figure 4c), and S4 is about as wide at level of apical carina as 0.28–0.37 of its length. Hamule inner branch is small and ends in a short point, outer branch is larger, with a blunt tip bent ventrally over inner branch; outer corner of outer branch is smoothly rounded (Figures 10g, 11h). Basal portion of distal segment of vesica spermalis is ca. trapezoidal in ectal view (Figure 13g), with distal lobes represented on each side by a medioventral semicircular membranous lobe with a sclerotized lateral projection margined with denticles, and an elongate outer lobe approximately rectangular in lateral view, about as long as basal portion (Figure 12g), with paired flagella on ental surface. Cercus (Figure 14f) is markedly curved ventrally in lateral view, with tip upturned (Figure 15i). Epiproct apex is about as wide as 0.50–0.55 of its maximum width, and is slightly bifid (Figure 16g–h).

Male of *O. cinnamomea* shares apex of epiproct wide (ca. 0.50 of epiproct maximum width or wider) and bifid with *O. aciculata*, *O. anthracina*, *O. celata*, *O. coracina*, and *O. harpago*. It differs from all of them by its reddish brown frons and vertex (versus metallic purple or blue), and except for *O. harpago*, by abdomen base narrowing abruptly (Figure 4c, versus narrowing gradually, Figures 4a, b, e, 19c). It can be further diagnosed from *O. harpago* by shape of hamule, with inner branch shorter than outer branch and in the same plane (Figures 10g, 11h; versus inner branch longer than outer branch and parallel to it, Figures 9f, 10n, 11h).

Female shares with male: labial palp with narrow medial black stripe, ca. 0.33 of palp width, pterothorax reddish brown with yellow stripes, and relatively slender abdomen narrowing abruptly from S2 to S4 (Figure 7f), with S4 as wide at apex as 0.30–0.39 of its length. Color of dorsal abdominal terga is similar to that of male. Ventrolateral flap on S8 (Figures 17f, 19b) is white, as wide as 0.31–0.34 of its length. Vulvar lamina of S8 consists of a medial longitudinal ridge anterior to posterior margin of sternum S8, enclosed anterolaterally by semicircular ribs, as wide as 0.30 of sternum width, with anterior corners projected anterolaterally and convex (Figure 18h).

Female shares a similar vulvar lamina with *O. aciculata*, *O. anthracina*, *O. coracina*, *O. cultriformis*, *O. faaseni*, and *O. harpago*. Its shape is unique among them by medial longitudinal ridge relatively narrow, as wide as 0.30 of sternum width, and anterior corners of transverse ridge projected anterolaterally and convex (in *O. anthracina* anterior corners of ridge are projected

laterally and are concave, Figure 18g; in *O. coracina* and *O. harpago*, anterolateral projections of ridge's anterior edge are concave; Figure 18j, o; in *O. aciculata* and *O. cultriformis* the ridge is not projected anterolaterally, Figure 18a–b, k), and in *O. faaseni* and *O. harpago* it occupies 0.50 of S8 width, Figure 18l, o). It further differs from all of them except for *O. harpago* by abdomen narrowing abruptly at base, with base of S4 as high as less than half of base of S3 in lateral view (Figure 7f; versus narrowing gradually, with base of S4 as high as more than half of base of S3 in lateral view, Figure 7a, d, h, i), and from *O. harpago* by S8 lateral flap relatively wider, as wide as 0.31–0.34 of its length, and triangular in shape (Figure 17f, versus lower, as high as 0.29 of its length, and ca. smoothly convex, Figure 17m).

Remarks

Additional specimens examined since the original description of this species agree well with the type series.

Distribution and biology

Orthemis cinnamomea is found from Ecuador to N Peru (Figure 23), associated with forested streams, rivers, and lakes.

Orthemis concolor Ris, 1919

Figures 4d, 7g, 8g, 10h, 11i, 12h, 13i, 14g, 15j, 16i, 17g, 18i, 19g–h, 24

Orthemis attenuata nec (Erichson, 1848) – Ris (1910, pp. 281, 292, in part; misidentification). *Orthemis concolor* Ris, 1919 (pp. 1105–1106; diagnosis from *O. attenuata*, description of syntypes from Trinidad, Guyana, and Surinam); von Ellenrieder (2009, pp. 349, 374, 378, figures 6f, 8f, 9f, 11c, 13b, 14f, 15f, 16c, 18b, 19, table 1; inclusion in key, illustrations of S4, hamule, vesica spermalis, S10, map).

Type specimens examined

Lectotype, designated here: 1 ♂, Surinam, Commewijne Dist., Voorburg (5°53' N, 55°5' W), 24 February 1912, leg. L.A. & E.B. Williamson & B.J. Rainey [UMMZ]. 7 ♂, 2 ♀ Paralectotypes [all leg. L.A. & E.B. Williamson & B.J. Rainey, in UMMZ]: 4 ♂, 1 ♀, same as lectotype; 1 ♂, Guyana, Demerara-Mahaica Region, Georgetown (6°48' N, 58°10' W), 25 January 1912, leg. L.A. & E.B. Williamson & B.J. Rainey; 1 ♀, same but 27 January 1912; 1 ♂, Trinidad, St. George County, San Juan (10°39' N, 61°27' W), 2 March 1912; 1 ♂, Trinidad, St. George County, Baracon Chaguaramas (10°42' N, 61°37' W), 7 March 1912.

Other specimens examined

Total 8 ♂, 2 ♀: 1 ♂, 1 ♀, Trinidad, St. Andrew County, Aripo Savanna (10°36' N, 61°12' W), 6 May 1988, leg. S.W. Dunkle [RWG]; 1 ♂, same but [FSCA]; 1 ♂, Trinidad, St. George County, Arima River at Churchill, Roosevelt Highway, about 2.25 mi. SSE of Arima (10°35'17" N, 61°14'48" W), 7 April 1980, leg. RWG [RWG]; 1 ♂, French Guiana, de la Guyane, Cacao (4°35' N, 52°28' W), 31 August 2001, leg. P. Johnson [RWG]; 1 ♂, French Guiana, Cayenne, Pointe Mahury (4°25' N, 51°56' W), 10 September 1989, leg. B. Hermier [RWG]; 1 ♀, French Guiana, Régina, stream Angéle, first waterfall (4°09'16" N, 52°20'02" W), 20 October 2007, leg. L. Juillerat [JJD]; 1 ♂, Brazil, Pará State, Belém (1°27' S, 48°30' W), 5 August 1922, leg. J.H. Williamson & J.W.

Strohm [FSCA]; 1 ♂, Brazil, Pará State, Ananindeua (1°21'57" S, 48°22'19" W), 7 September 1964 [MZUSP]; 1 ♂, Brazil, Bahia State, Alcobaca (17°30' S, 39°13' W), January 1982, leg. A.B.M. Machado [RWG].

*Lectotype designation for *Orthemis concolor**

Ris (1919, p. 1106) described *O. concolor* based on a large series of specimens without designating a holotype, including four males and one female from “Pará” in Selys’s collection, two males from Surinam and Guyana in Martin’s collection, one male from “Pará” in his own collection, and 22 males and five females from Surinam, Guyana, and Trinidad in Williamson’s collection. In order to confirm the correct application of the name I borrowed the syntypes from Williamson’s collection, now deposited at UMMZ. Since the large type series could include more than one species, in order to preserve stability of nomenclature and ensure a consistent application of the name, I hereby designate one of the male syntypes deposited at UMMZ studied by Ris (1919, p. 1106) and illustrated here (Figure 4d) as lectotype of *Orthemis concolor* to act as the unique name-bearing type of this taxon. Original type labels accompanying lectotype are as follows (handwriting in italics): [*Orthemis* – 2 ♂ *b./ concolor n.sp.*] [Voorburg, Surinam./ Feb. 24-. 12.] [L.A.&E.B. Williamson/ & B.J. Rainey]. The lectotype agrees well with Ris’s (1919) description of the male. Its main venational characters and dimensions are: one cubito-anal crossvein and arculus between Anx 2 and Anx 3, closer to Anx 2 in Fw, midway in Hw; Fw subtriangles with 4 cells; one bridge crossvein; Fw discoidal field with 3 rows of cells at base to 5 (right)–6 (left) rows at hind margin, Hw with 3 at base, then 2, then increasing to 14 (right)–16 (left) at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 19 (right)–22 (left) cells. Pt reddish brown orange, overlying 5 cells. Anx: 18 in Fw, 15 (right)–14 (left) in Hw; Pnx: 16 in Fw, 15 in Hw; total length 49.6; abdomen length 32.7; Fw length 39; Hw length 38.3; Hw maximum width 10.4; Fw Pt length 4.7; Hw Pt length 4.5; S4 length 6.2; S4 apical width 1.7; cercus length 2.35; epiproct length 1.9; epiproct maximum width 0.9; epiproct subapical width 0.35.

Diagnosis

Male of *O. concolor* has pale to dark reddish brown frons and vertex, labial palp with medial black stripe as wide as 0.33–0.40 of palp width, pterothorax concolorous reddish brown (Figure 19g) with ill-defined diffuse yellow areas on sides of pterothorax in young males, dorsal terga S1–3 mostly reddish brown to orange, and S4–10 mostly black with narrow yellow to orange stripes along S4–7 medial longitudinal carinae and along S4–5 to S4–8 ventrolateral carinae (Figure 19g). Abdomen narrows abruptly from S2 to S4 (Figure 4d), and S4 is about as wide at level of apical carina as 0.25–0.30 of its length. Hamule inner and outer branches are located in the same plane, with both ending at about the same level (Figure 10h); inner corner of outer branch is smoothly rounded (Figure 11i). Distal segment of vesica spermalis is ca. oval, with sides gradually converging to distal end in ectal view (Figure 13i), paired distal short medial longitudinal membranous lobes beset with denticles along distal margin on ectal side, paired outer lateral lobes shorter than basal sclerotized portion of distal segment folded medially to the sides (Figure 12h), and with paired flagella. Cercus (Figure 14g) curves ventrally gradually (Figure 15j) and its tip is slightly upturned. Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16i). Male of *O. concolor* shares combination of abruptly narrowed abdomen at base and epiproct tip narrow and entire only with *O. attenuata* and *O. levis*. These three species are very similar morphologically, differing almost solely by color pattern. *Orthemis concolor* differs from *O. attenuata* and *O. levis* by its frons and vertex reddish brown and pterothorax concolorous

reddish brown (Figure 19g), sometimes with ill-defined diffuse yellow areas on mesepisternum, versus metallic purple frons and vertex, in teneral males reddish brown with some metallic purple reflections on frons furrow and around ocelli, and pterothorax with yellow stripes (Figure 19f), which can however be obscured in mature males (Figure 19e), and it further differs from *O. levis* by its abdominal color pattern, with S1–3 mostly reddish brown to orange and S4–10 mostly black with only narrow yellow to orange medial longitudinal stripes on S4–7 and ventrolateral stripes on S4–5 to S4–8 (Figures 4d, 19g), versus S1–7 mostly red, with only S8–10 dorsally black in *O. levis*, and by shape of abdomen base between apex of S2 and base of S3, which is more markedly globose (Figure 4d; versus less globose, as in Figure 7m).

Female shares with male: labial palp with narrow medial black stripe (0.33–0.40 of palp width), pterothorax almost uniformly reddish brown with ill-defined diffuse yellow areas on sides in young specimens, and slender abdomen narrowing abruptly from S2 to S4 (Figure 7g). Color of dorsal abdominal terga is similar to that of male. Ventrolateral flap on S8 is yellow and relatively narrow, ca. 0.27 as wide as its length, with a smoothly curved contour (Figure 17g). Sternum S8 is smooth, with vulvar lamina consisting of posterior margin of S8 forming a shallow inverted U-shaped rim, with medial excision narrower than its lateral margins (Figure 18i). Combination of relatively slender abdomen narrowing abruptly at base, with base of S4 as high as less than half of base of S3 in lateral view, and vulvar lamina consisting of shallow inverted U-shaped rim of S8 posterior margin is shared only with *O. attenuata* and *O. levis*. *Orthemis concolor* differs from both by its pterothorax concolorous reddish brown (Figure 19h) with ill-defined yellow areas in teneral specimens, versus pterothorax with yellow stripes, and by the position of the paired depressions anterior to vulvar lamina rim, which are located laterally to the lateral margins of the medial excision of rim (Figure 18i), versus located directly anterior to the lateral margins of the rim (Figure 18e). It further differs from *O. levis* by dorsal terga S4–7 mostly dark reddish brown to black with narrow mediodorsal and ventrolateral pale stripes versus mostly red, and by shape of abdomen base between apex of S2 and base of S3, which is more markedly globose (Figure 7g; versus less globose, Figure 7m). However, red color on abdominal dorsal terga S4–7 in females of *O. levis* is not as pronounced as it is in males, being sometimes replaced by orange to reddish brown, which especially in poorly preserved specimens looks then very similar to the pattern of *O. concolor*.

Distribution and biology

Orthemis concolor is found from Venezuela and Trinidad through the Guyanas to N Brazil (Figure 24), associated with forested streams and rivers.

***Orthemis coracina* von Ellenrieder, 2009**

Figures 1f, 2i–j, 4e, 6e, 7h, 8h, 10i, 11k, 12i, 13h, 14h, 15k, 16j, 17h, 18j, 19i–j, 25

Orthemis coracina von Ellenrieder, 2009 (pp. 357, 374, 379, figures 1a, 2d, 4b, 8h, 9g, 11d, 12b, 14g, 15g, 20, table 1; description, illustrations of labium, pterothorax, S1–3, hamule, vesica spermalis, S10, map, inclusion in key; male holotype Limoncocha, Sucumbíos Prov., Ecuador, in USNM).

Orthemis flavopicta nec Kirby, 1889 – Belle (2002, p. 5, record from Surinam; misidentification).

Type specimens examined

1 ♂ Holotype, Ecuador, Sucumbíos Prov., Limoncocha, forest edge (0°24'0" S, 76°36'0" W), 23 July 1977, leg. D.R. Paulson [USNM].

Other specimens examined

Total 12 ♂, 3 ♀: 3 ♂, Colombia, Antioquia Dept., Puerto Berrío (6°30' N, 74°24' W), 31 January/8 February 1917, leg. J.H. & E.B. Williamson [UMMZ]; 1 ♂, 1 ♀ (in copula), Surinam, Sipaliwini Dist., Sipaliwini, stream near airstrip (2°6'0" N, 2 56°2'00" W), leg. D.C. Geijskes, 16 February 1961 [RMNH]; 1 ♂, same but Langatabbetje, Sarakreek (5°0'0" N, 54°31'0" W), 12 December 1965, leg. G. F. Mees [RMNH]; 1 ♂, same but Sipaliwini river at Werehpai (2°21'45" N, 56°41'56" W), 7 September 2010, leg. NE [RWG]; 1 ♀ same but Kabalebo, Aranavero (04°25'00" N, 57°13'00" W), 10 April 1971, leg. D. Geijskes [RMNH]; 1 ♀ Brazil, Pará State, Rio Gurupí, Aldea Yavaruhu, 50 km E of Canindé (0°30'11" S, 50°50'00" W), 11–25 February 1966, leg. B. Malkin & J.C. Pinh. [RMNH]; 1 ♂, Brazil, Rondônia State, Villa Murtinho (10°21' S, 65°19' W), 2 April 1922, leg. J.H. Williamson & J.W. Strohm [UMMZ]; 1 ♂, Peru, Loreto Dept., Leticia (7°0' S, 74°12' W), 29 June 1920, leg. H.S. Parish [UMMZ]; 1 ♂, Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, small stream within forest (4°23'5" S, 73°15'4" W), 10 August 2009, leg. TF [TF]; 1 ♂, same but small stream within forest (4°24'1" S, 73°15'40" W), 31 July 2009, leg. TF [TF]; 2 ♂, Peru, Loreto Dept., Explorama Lodge, 50 mi NE Iquitos on Amazon River at junction with Yanamono River (3°21'59" S, 72°47'56" W), 12/14 August 1989, leg. S.W. Dunkle [RWG].

Description of female

Head. Prementum black; labial palps pale yellow with medial black stripe as wide as about 0.40 of palp width and anterior margin narrowly black (as in Figure 1f); labrum black with a mediobasal reddish spot or with pair of rounded laterobasal pale yellow spots; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, remainder of anteclypeus pale reddish brown, postclypeus pale reddish brown with medial dark brown spot and postclypeal lobes narrowly fringed with dark brown line along distal margin; ventral half of antefrons reddish brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex reddish brown, occipital triangle red to reddish brown posteriorly, rear of head orange to reddish brown around occipital triangle and yellow along eyes. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown except pale yellow anterior and posterior lobes. Pterothorax (Figure 2j) reddish brown with pale yellow stripes as follows: narrow diffuse stripe lateral to mediodorsal carina, wider diffuse stripe at mid width, and small spot at mesepisternal–mesepimeral suture ventral kink; mesepimeron with wide stripe along posterior half narrowing dorsally; metepisternum with narrow stripe along ventral margin and another sinuous one ventral to metastigma, and oval spot on posterodorsal corner; metepimeron with stripe along posterior half, narrowing dorsally, and a triangular spot on anterodorsal corner; venter of pterothorax pale yellow with triangular reddish brown spot on each side extending from base of leg and narrowing to posterior margin. – Legs with coxa, trochanter, and basal 0.50 of inner surface of pro- and mesofemur pale brown to pale yellow; femur reddish brown; tibia dark reddish brown, tarsus, pretarsus, and spines black; metafemur with 11 to 20 short spurs which slightly and gradually increase in size towards apex, followed distally by one or two longer spurs. – Wings hyaline with small amber spots at base extending to level of first row of anal cells in FW, and to level of second row and distal end of membranula in HW, very narrow reddish tinge around nodus, and distal amber spot extending from level of distal end of pterostigma to apex. One cubito-anal crossvein and arculus distal to Anx 2 in Fw and HW; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 5–7 rows at hind margin, Hw with 3 at base, then 2, then increasing to 14–15 at hind margin; 3 rows of cells between wing margin and anal loop at level

of anal angle of triangle; anal loop enclosing 21–25 cells. Pt reddish brown, 4.6–4.8 long in Fw and 4.5–4.6 in Hw, overlying 5 cells in Fw and 5–6 cells in Hw. Anx: 18–19 in Fw; 13–15 in Hw; Pnx: 14–17 in Fw; 15–18 in Hw.

Abdomen. Sides linear, gradually narrowing from S3 to S4 in ventral view (Figure 8h), S4 about three times as long as wide (ratio width/length = 0.30–0.33). Dorsal terga (Figure 7h) S1–7 orange red, except for mid-dorsal and ventrolateral pale yellow stripes, and pair of small faint dark oval spots on posterolateral corner of S3–6 and posterior 0.2 black on S7 in two females, in one female S4–7 orange red lacking yellow ventrolateral stripes; S8–10 black with mid-dorsal carina narrowly pale yellow. Ventrolateral carina on S2 vestigial, on S3–8 well developed and black, on S9 absent. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 8h): S1 and S2 dark reddish brown with yellow along ventrolateral carinae; S3–7 dark reddish brown with yellow stripe along lateral margin on basal two thirds of segment; S8 pale brown; S9 dark reddish brown; S10 black. Ventrolateral flap on S8 pale yellow (Figure 17h). Vulvar lamina on sternum of S8 extending along posterior 0.25 of S8 length, with free transverse anterior ridge projected into two triangular, concave points directed anteriorly, and medial longitudinal ridge transversally ridged extending to S8 posterior margin (Figure 18j). Appendages dark reddish brown.

Dimensions ($n = 3$). Total length 52–53 [52.66 ± 0.57]; abdomen length 36–37.8 [36.96 ± 0.9]; Fw length 38–39.7 [38.76 ± 0.86]; Hw length 36.4–38.3 [37.26 ± 0.96]; maximum Hw width 10.2–10.3 [10.23 ± 0.05]; ventrolateral flap on S8 length 2.9–3.1 [2.96 ± 0.11], width 0.85 [0.85 ± 0]; ratio width/length 0.27–0.29 [0.28 ± 0.01]; cercus length 1.1–1.35 [1.23 ± 0.12], epiproct length 0.6–0.7 [0.66 ± 0.05], epiproct width at base 0.8–1.04 [0.98 ± 0.16].

Variation in males

Head. As for female but labial palp medial black stripe as wide as about 0.50–0.70 of palp width (Figure 1f); labrum black; clypeus and basal portion of antefrons pale to dark reddish brown to black medially; dorsal portion of antefrons and postfrons in two teneral males reddish brown with purple reflections and vertex metallic blue; in four males antefrons, postfrons, and vertex metallic purple with blue reflections; in one male antefrons and postfrons metallic purple with blue reflections and vertex metallic blue; in three males antefrons, postfrons, and vertex bright metallic blue with purple reflections, and in two males bright metallic blue with turquoise reflections; occipital triangle pale reddish brown to dark reddish brown to black.

Thorax. Prothorax as for female to dark reddish brown to black. Pterothorax as in female in two teneral males, dark reddish brown with yellow diffuse stripes (as in Figure 2j), to black on mesepisternum and very faint yellowish stripes on metepimeron and metepisternum in five males (Figure 19i), to almost entirely black with greenish-blue metallic reflections with some restricted brown areas on ventral portion of sclerites in five males (Figures 2i, 19j). Venter of pterothorax as in female to black with central area brown. – Legs as in female to black with lateral and extensor surfaces of procoxa and protrochanter pale brown; metafemur armed with 23–33 short spurs, usually followed by 1 longer spur, rarely by two. – Anal loop enclosing 20–25 cells. Pt pale to dark reddish brown. Fw Anx: 16–20; Hw Anx: 12–15; Fw Pnx: 12–15; Hw Pnx: 13–17.

Abdomen. As for female but S4 as long as ca. twice to three times its apical width (ratio apical width/length = 0.33–0.48). Dorsal terga S1–7 mostly red with posterodorsal black spot in one teneral male, black spot extending to posterior margin on S3–7 in two males (Figure 19i), along most of S5–7 length in two males, and S3–7 almost entirely black (Figure 19j) in three males; S8

black with ventrolateral red stripe to all black; S9–10 and caudal appendages black. Ventrolateral carina on S2 vestigial, on S3–8 well developed and black, on S9 well developed along basal two thirds, absent at distal third. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 6e): mostly black to dark reddish brown or black with yellow stripe along ventrolateral carinae on S1–7; S8–10 dark reddish brown to black. Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Figure 10i); hamule bifid with small inner branch forming a short pointed spine, and larger outer branch bent ventrally over inner branch with blunt square tip; outer corner of outer branch angled (Figure 11k). Distal segment of vesica spermalis with basal portion trapezoidal in ectal view (Figure 13h), and with long flagella on ental surface; distal lobes represented on each side by medioventral semicircular membranous lobe with sclerotized lateral projection margined with denticles, and elongate outer lobe approximately rectangular and ca. as long as basal portion in lateral view (Figure 12i). Cercus markedly curved ventrally in lateral view, with tip slightly upturned, with row of 5–7 tubercles along distal dilated portion (Figure 15l); in dorsal view converging along basal 0.70 with opposite cercus, then approximately parallel to it along distal 0.30 (Figure 14h). Epiproct extending to 0.73–0.86 of cerci length, its apex bifid and as wide as 0.64–0.75 of its maximum width (Figure 16j).

Dimensions ($n = 10$). Male total length 42.8–48.1 [45.42 ± 1.71]; abdomen length 26.6–31 [28.94 ± 1.45]; Fw length 35–39 [37.36 ± 1.17]; Hw length 34–38.2 [36.23 ± 1.18]; maximum Hw width 10–11.2 [10.49 ± 0.36]; Fw Pt length 4.1–4.5 [4.32 ± 0.15]; Hw Pt 4–4.4 [4.19 ± 0.14]; S4 ratio apical width/ length 0.33–0.48 [0.42 ± 0.05]; cercus length 1.75–1.95 [1.84 ± 0.07]; epiproct length 1.35–1.6 [1.51 ± 0.08]; epiproct maximum width 0.9–1.1 [1.04 ± 0.07]; epiproct subapical width 0.6–0.65 [0.62 ± 0.02].

Diagnosis

Male of *O. coracina* shares apex of epiproct wide, ca. 0.50 of epiproct maximum width or wider, and bifid with *O. aciculata*, *O. anthracina*, *O. celata*, *O. cinnamomea*, and *O. harpago*. Among them, it shares outer corner of outer branch of hamule roundly angled only with *O. harpago* (Figure 18k, m; versus smoothly rounded, Figure 18a, d, f, h), but differs from the latter by inner branch ca. as long as outer branch (Figure 11k, versus longer than outer branch, Figure 11m). It further differs from *O. aciculata* by tip of inner branch almost touching the tip of the outer branch (versus separated by distance of ca. twice inner branch length, Figure 11a); from *O. anthracina* by medioectal lobes of vesica spermalis distal segment almost reaching tip of outer lobes (Figure 12i; versus distinctly shorter than outer lobes, Figure 12d); from *O. cinnamomea* by frons and vertex metallic purple with blue reflections (versus reddish brown); from *O. celata* by inner branch visible in frontal view (Figure 11k; versus appressed against outer branch medial surface and hidden from view, Figure 11f).

Female shares a similar vulvar lamina, characterized by the presence of a medial longitudinal ridge anterior to posterior margin of sternum S8, with *O. anthracina*, *O. aciculata*, *O. cinnamomea*, *O. cultriformis*, *O. faaseni*, and *O. harpago*. Among them, it is most similar to *O. cinnamomea*, *O. faaseni*, and *O. harpago* by the shape of the transverse anterior ridge, which has triangular projections directed anterolaterally (Figure 18h, j, l, o). However, unlike in *O. faaseni* and *O. cinnamomea* these projections are concave (Figure 18k, versus convex, Figure 18h, o). It further differs from *O. faaseni* by S4 longer and narrower (S4 length 5.0–5.5 mm and S4 apical width/length 0.30–0.34, versus S4 length 4.3 mm and S4 apical width/length 0.53), and S8 flap whitish (Figure 17h; versus reddish brown, Figures 17j, 19l), from *O. cinnamomea* and *O. harpago* by abdomen narrowing more gradually at base (Figure 7h; versus more abruptly, Figure 7f, l),

from *O. aciculata* by S4 relatively narrower (S4 apical width/length 0.30–0.34, versus 0.38–0.53), and from *O. cultriformis* by relatively narrower ventrolateral S8 flap, with ratio width/length of 0.27–0.29 (Figure 17h; versus relatively wider, with ratio width/length of 0.33–0.37, Figure 17i).

Remarks

Male color pattern was found to be variable, probably related to age, from very similar to that of females in teneral males – as indicated by their shiny wing membranes and abdomen crushed due likely to softness of integument at time of fixing – with yellow stripes on thorax and abdomen mostly red, except for metallic reflections of frons and vertex metallic and wider extension of black on labial palp, to very dark, probably corresponding to older mature males, in which the black on labial palp is the widest, frons and vertex are metallic blue, and thorax and abdomen are almost entirely black. Variation in males above includes the holotype; holotype was borrowed and its vesica spermalis was redrawn (Figures 12i, 13h) after cleaning some dry substance that had previously obscured the shape of the lobes in ectal view.

Several specimens of *O. coracina* were found in different collections misidentified as *O. cultriformis* [UMMZ] and *O. flavopicta* [RMNH].

Distribution and biology

Additional material of *O. coracina* examined since its original description increases its range of distribution to encompass Colombia, Surinam, and N Brazil to Ecuador and N Peru (Figure 25). This species occurs along rivers, creeks, and streams within tropical lowland forest.

Orthemis cultriformis Calvert, 1899

Figures 2k, 9d, 10j, 11j, 12j, 13j, 15l, 16k, 17i, 18k, 21

Orthemis cultriformis Calvert, 1899 (p. 31, figure 4; description, illustration of male genital fossa, inclusion in key); Calvert, 1906 (pp. 234, 239; inclusion in key); Ris (1910, pp. 281, 291; inclusion in key); Ris, 1919 (p. 1104, in part; redescription); von Ellenrieder (2009, pp. 349, 351, 375, 380, figures 2, 8i, 9h, 12c, 14h, 15h, 16f, 18e, 20, plate VIIc, table 1; inclusion in key, map, color picture of male, designation of male lectotype from San Pedro, Paraguay, in ANSP).

Orthemis flavopicta nec Kirby, 1889 – Ris (1910, p. 290, at least in part; misidentification of female from Pará, in UMMZ).

Specimens examined

Total 272 ♂, 21 ♀: 1 ♂, Panama, Panamá Prov., trail at milepost 12, by Gaillard Hwy., 7.4 km SE of Gamboa (9°4' N, 79°40' W), 3 August 1979, leg. RWG & J.A. Garrison [RWG]; 1 ♀, Trinidad, St. Andrew County, Aripo Savanna (10°36' N, 61°12' W), 4 May 1988, leg. S.W. Dunkle [FSCA]; 1 ♂, same but [RWG]; 1 ♂, same but forest cut and forest 2 mi SE of Valencia on Eastern Main road (10°37'26" N, 61°10'55" W), 7 April 1980, leg. RWG & J.A. Garrison [RWG]; 1 ♂, same but Valencia, forest SE of town (10°39' N 61°13' W), 15 April 1965, leg. T.W. Donnelly [RWG]; 2 ♂, Trinidad, Caroni Co., shaded still water area 1.5 mi W of Navit Dam, 14 January 1981, leg. RWG [RWG]; 5 ♂, Trinidad, St. George Co., forest and small stream along trail called Indian Walk Ride off main road, 1.9 mi N of Cumuto (10°36' N, 61°12' W), 7 April 1980, leg. RWG & J.A. Garrison [RWG]; 1 ♂, Trinidad, St. George Co., Arima (10°38' N 61°16' W), 4 March 1912, leg. L.A. & E. B. & B.J. Rainey [UMMZ]; 3 ♂, Trinidad, Saint David Co., Todds road

(10°28' N, 61°20' W), 9 March 1932, leg. G. Belmontes [UMMZ]; 1 ♂, Venezuela, Bolívar State, Río Cinco Ranchos, 15 km E. of El Paují (4°36'4" N, 61°24'64" W), 7 August 1990, leg. RWG [RWG]; 8 ♂, Venezuela, Táchira State, Táchira (8°7'4" N, 72°15'19" W), 6–12 April 1920, leg. J.H., E.B. Williamson & W.H. Ditzler [UMMZ]; 1 ♂, same but [RWG]; 11 ♂, Venezuela, Táchira State, La Fría (8°13'7" N, 72°14'55" W), 12–16 April 1920, leg. J.H., E.B. Williamson & W.H. Ditzler [UMMZ]; 9 ♂, Guyana, Potaro-Siparuni Region, Tumatumari (5°17' N, 58°59' W), 5–12 February 1912, leg. L.A. & E.B. Williamson & Rainey [UMMZ]; 1 ♀, Surinam, Voorburg (5°53' N, 55°5' W), 24 February 1912, leg. Williamson & Rainey [UMMZ]; 1 ♂, Surinam, Sipaliwini Dist., Kabalebo, Aranavero (4°25' N, 57°13' W), 10 April 1971, leg. D.C. Geijskes [RMNH]; 1 ♂, same but Werehpai, forest creek (2°21'46" N, 56°41'53" W), 3 September 2010, leg. NE [NE]; 1 ♂, same but [RWG]; 1 ♂, French Guiana, small pond by N2 at PK25 (4°30' S, 52°12' W), 19 February 1988, leg. RWG [RWG]; 4 ♂, Colombia, Antioquia Dept., Cristalina (6°29' N, 74°50' W), 13–20 February 1917, leg. J.H. & E.B. Williamson [UMMZ]; 1 ♂, Colombia, Arauca Dept., Río Casanare, palmar (6°16'11" N, 71°4'24" W), 20 April 1917, leg. M.A. Carriker [UMMZ]; 2 ♂, 1 ♀, Brazil, Pará State, Rio Gurupí, Canindé (0°31'0" S, 51°13'59" W), 27/28 February 1966, leg. B. Malkin [RMNH]; 1 ♂, Brazil, Pará State, Floresta Nacional de Carajás, Parauapebas, Buritizal I (6°5'13" S, 50°8'50" W), 5 March 2008, leg. N. Ferreira, Jr. & A. Santos [DZ RJ]; 1 ♂, same but Buritizal II (6°4'13" S, 49°56'59" W), 24 September 2007, leg. N. Ferreira, Jr. & V. Alecrim [DZ RJ]; 1 ♂, 1 ♀, Brazil, Pará State, Pará (1°27' S, 48°29' W), 3 December 1892, leg. O.S. Staudinger [UMMZ]; 1 ♂, Brazil, Pará State, Belém (1°27' S, 48°30' W), 5 August 1922, J.H. Williamson & J.W. Strohm [UMMZ]; 1 ♂, Brazil, Rondônia State, Villa Murtinho (10°21' S, 65°19' W), 4 April 1922, leg. J.H. Williamson & J.W. Strohm [UMMZ]; 1 ♂, same but 7 April 1922 [UMMZ]; 2 ♂, same but Porto Velho (8°46' S, 63°54' W), 21 February 1922 [UMMZ]; 1 ♂, 1 ♀ (in copula), Brazil, Rondônia State, 60 km S Ariquemes, Fazenda Rancho Grande, farm of Harald Schmitz and environs within about 15 km radius (10°31'48" S, 61°48'0" W), 16/24 March 1989, leg. S.W. Dunkle [RWG]; 3 ♂, same but 2/11 November 1989, leg. RWG [RWG]; 8 ♂, 1 ♀, same but stream ca. 7 km SE of Cacauplandia, ca. 70 km S of Ariquemes (10°31'48" S, 62°48'0" W), 7 November 1989 leg. RWG [RWG]; 1 ♀, same but 2 km N Cacauplandia, on B-65, línea C-17, dry trail 164 (10°19'25" S, 62°54'0" W), 16 November 1991, leg. M. J. Westfall, Jr. [FSCA]; 2 ♂, Brazil, Rio de Janeiro State, Cachoeira de Macacu, Santana de Japuiba, Rio São João (22°34'5" S, 42°39'24" W), 10/11 December 2000, leg. RWG [RWG]; 1 ♀, Ecuador, Morona-Santiago, Gualaquiza, 14–15 May 1935, leg. F. Campos R. (3°24'22" S, 78°34'18" W) [FSCA]; 1 ♂, Ecuador, Morona Santiago Prov., Macas, Río Upano (2°19' S, 78°7' W), leg. L. Gómez Alonzo [UMMZ]; 6 ♂, Ecuador, Morona Santiago Prov., Mangosisa, Río Upano (2°31'28" S, 77°53'41" W), L. Gómez Alonzo [UMMZ]; 3 ♂, Ecuador, Napo Prov., Jatún Yacu, Río Napo watershed (1°1' S, 77°50' W), 12–16 February 1937, leg. W. Clarke-MacIntyre [UMMZ]; 2 ♂, Ecuador, Napo Prov., Jatún Sacha Biological Station, 23 km E Puerto Napo, tropical wet forest, ponds nearby (1°3' S, 77°47' W), 18 October 1988, leg. S.W. Dunkle [FSCA]; 2 ♂, same but ponds nearby Jatún Sacha Biological Station, 23 km E Puerto Napo, tropical wet forest (1°3' S, 77°47' W), 18 October 1988, leg. S.W. Dunkle [RWG]; 1 ♂, Ecuador, Napo Prov., Río Sindy on Jatún Sacha Road, 5.3 km E Puerto Napo, 22 July 1996, leg. Bill Mauffray [FSCA]; 2 ♂, same but 5.3 km E Puerto Napo, tropical wet forest, clear cobbler bottom, most odonates at varied side slough, 16 October 1988, leg. S.W. Dunkle [FSCA]; 1 ♀, Ecuador, Napo Prov., Río Chinchipino, 27 km E of Puerto Napo on Jatún Sacha road (1°4'24" S, 77°35'12" W), 13 July 1996, leg. S.W. Dunkle [FSCA]; 1 ♂, Ecuador, Orellana Prov., Tiputini Biodiversity Station USFQ, swamp at marker 650 of Parahuaco trail (0°38'23" S, 76°8'43" W), 21 January 2009, leg. RWG & NE [NE]; 1 ♂, same but black water stream crossing Guacamayo trail at marker 2050 (0°38'18" S, 76°8'57" W), 16 January 2009 [RWG]; 1 ♂, same but Yasuni National Park, small stream, swamp & pond 5.6 km W Yasuni Rd on PC 29–30 (0°42'48" S, 76°18'0" W), 10 June 1995, leg. S.W. Dunkle [RWG]; 2 ♂, Ecuador, Orellana Prov., Yasuni National Park, shallow swamp W of Yasuni Rd on PC 29–30

(0°38' S, 76°30' W), 10 June 1995, leg. S.W. Dunkle [FSCA]; 2 ♂, Ecuador, Orellana Prov., Biological Station, Parque Nacional Yasuni (0°42' S, 76°28' W), 18 July 1996, leg. S.W. Dunkle [FSCA]; 1 ♂, same but pond, road to Waorani Reserve, 5.6 km S of turn to Yasuni Scientific Research Station, 10 June 1995, leg. K.J. Tennessen [FSCA]; 1 ♂, same but Reserva Étnica Waorani, 1 km S Okone Gare Camp, canopy fogging project, Lot #973 TR1 #4, terra firme forest, in Lab. Building (0°39'25" S, 76°27'10" W), 8 February 1995, leg. T. L. Erwin et al. [USNM]; 1 ♀, same but Lot #1054, by hand in Lab., 14 February 1995 [USNM]; 1 ♂, Ecuador, Pastaza Prov., Puyo, Río Pastaza watershed (1°29' S, 78°3' W), 28 November 1936, leg. W. Clarke-MacIntyre [UMMZ]; 1 ♂, Ecuador, Sucumbíos Prov., Lago Agrio, 7 km W on Hwy 45, swamp & stream (0°5'4" N, 76°58'44" W), 8 June 1995, leg. S.W. Dunkle [FSCA]; 2 ♂, same but stream and pool in forest E edge of town of Lago Agrio (0°6' N, 76°52' W), 18 August 1980, leg. S. W. Dunkle [FSCA]; 1 ♂, Peru, Loreto Dept., Explorama Inn, on Amazon River 25 mi E Iquitos (3°27'9" S, 72°52'31" W), 9 August 1992, leg. S.W. Dunkle [NE]; 1 ♀, Loreto Dept., Iquitos (3°46' S, 73°15' W), 18 June 1920, leg. H.S. Parish [UMMZ]; 1 ♂, Peru, Loreto Dept., Estirón, Río Ampí Yacu, indian clearing (3°51'55" S, 70°41'19" W), 3 December 1961, leg. B. Malkin [UMMZ]; 1 ♂, Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, cow meadow on edge of primary terra firme forest, near Río Blanco (4°21'45" S, 73°10'5" W), 18 February 2010, leg. TF [TF]; 4 ♂, Peru, Loreto Dept., Rumococha, Río Amazonas near Iquitos (3°51' S, 73°13' W), August 1939, leg. José Schunke [FSCA]; 3 ♂, Loreto Dept., Yurimaguas, Río Huallaga (5°53'49" S, 76°6'53" W), November 1939, leg. G.G. Klug [UMMZ]; 1 ♂, Peru, Loreto Dept., Yarinacocha, temporary forest stream (8°17' S, 74°37' W), 26 June 1972, leg. D.L. Pearson [RWG]; 2 ♂, Peru, San Martín Dept., vicinity of Rioja (6°2' S, 77°10' W), 10 September/3 November 1936, leg. F. Woytkowski [RWG]; 1 ♂, Peru, San Martín Dept., 3 mi SW of Tarapoto, Vaca-pozo, bank of Cumbaza River (6°31' S, 76°22' W), 25 February 1947, leg. F. Woytkowski [UMMZ]; 9 ♂, 1 ♀, Peru, San Martín Dept., 20 km NE Moyobamba, Mishqui-yacu (6°3' S, 76°58' W), 14–18 August 1947, F. Woytkowski [UMMZ]; 16 ♂, 2 ♀, Peru, San Martín Dept., vicinity of Rioja (Soritor) jungle (6°2' S, 77°10' W), 9–20 September 1936, F. Woytkowski [UMMZ]; 3 ♂, 2 ♀, Huánuco, Shapajilla (9°14' S, 75°58' W), 6–11 May 1939, leg. F. Woytkowski [UMMZ]; 1 ♂, Peru, Ucayali Dept., Aguaytia (9°2'13" S, 75°30'27" W), 31 August 1961, leg. F. Waltz [RWG]; 8 ♂, Peru, Ucayali Dept., Boquerón del Padre Abad, NE of Tingo María (7°18' S, 76°49' W), 9–21 August 1946, F. Woytkowski [UMMZ]; 9 ♂, 1 ♀, Junín Dept., La Merced, Hacienda La Salud (11°3' S, 75°19' W), leg. J. de D. Rivas S. [UMMZ]; 64 ♂, 4 ♀, Junín Dept., Satipo (11°16' S, 74°41' W), 18 May 1940/2 January 1941, leg. P. Paprzycki [UMMZ]; 8 ♂, August 1942 [UMMZ]; 2 ♂, same but, April–May 1945 [UMMZ]; 7 ♂, 1 ♀, Peru, Madre de Dios Dept., Pakitza Reserved Zone, Aguajal ca. 4.5 km E of Pakitza (11°55'48" S, 71°15'18" W), 5 July 1993, leg. RWG [RWG]; 1 ♂, same but 19 October 1987, leg. J.A. Louton [RWG]; 1 ♂, same but 20 September 1988, leg. J.A. Louton [RWG]; 1 ♂, same but 11 September 1989, leg. J.A. Louton [RWG]; 1 ♂, same but on trail to Cocha Chica, in fine cobble next to stream in forest with dappled sunlight (11°56'29" S, 71°17'50" W), 3 July 1993, leg. RWG [RWG]; 6 ♂, same but 9/21 September 1988, leg. O.S. Flint, Jr. [RWG]; 1 ♂, same but in mist nets, 10 September 1988 leg. Grace Servat [RWG]; 1 ♂, same but Hotel Amazonas, across from Atalaya (12°52'13" S, 71°22'34" W), 28 June 1993, leg. RWG [NE]; 1 ♂, Bolivia, Cochabamba Dept., Carrasco Prov., Valle del Sajta, just E of Univ. Mayor de San Simón Research Station, along road (km 232), 3 km N of Cochabamba Hwy, intermittent forest stream (17°5'14" S, 64°46'29" W), 16 November 1999, leg. Bill Mauffray [FSCA]; 1 ♂, same but Iuirgazama, 30 March 1990 [FSCA]; 1 ♂, Bolivia, Santa Cruz Dept., Buena Vista (17°27' S, 63°40' W), October 1934, leg. F. Steinbach [UMMZ]; 1 ♂, same but January 1937 [UMMZ]; 1 ♂, same but Ñuflo de Chávez Prov., San Javier, 26.2 km E on road to Concepción, forest seeps, pool & stream (17°21' S, 63°35' W), 16 November 1998, leg. Bill Mauffray [FSCA]; 1 ♂, same but Ichilo Prov., Lagunas Curichi, 3.5 km S of Buena Vista (17°27'0" S, 63°40'6" W), 8 February 2001, leg. JJD [JJD]; 1 ♂, Paraguay, Guairá Dept., Villarica (25°45' S, 56°26' W), 11 September 1938, leg. F.H. Schade

[FSCA]; 1 ♂, same but 5 November 1944, F.H. Schade [UMMZ]; 1 ♂, same but 1945 [UMMZ]; 1 ♂, Paraguay, Paraguari Prov., Sapucay (25°40' S, 56°55' W), November 1899, W.T. Förster [UMMZ].

Diagnosis

Male of *O. cultriformis* has metallic purple frons and vertex, labial palp with medial black stripe as wide as 0.33–0.50 of palp width, pterothorax reddish brown with yellow stripes (Figure 2k), which can be entirely obscured in mature males, and dorsal terga S1–7 mostly red to mostly dark reddish brown to black, with pale yellow to greenish ventrolateral stripes on S1–3, orange to red stripes along medial longitudinal carinae on S4–8 and along ventrolateral carinae on S4–5 to S4–8. Abdomen narrows gradually from S2 to S4, and S4 is about as wide at level of apical carina as 0.35–0.50 of its length. Hamule inner and outer branches are located in the same plane (Figure 9d), with outer branch bent ventrally over inner branch (Figure 10j), and outer corner of outer branch roundly angled (Figure 11j). Basal portion of distal segment of vesica spermalis is rhomboidal in ectal view (Figure 13j), distal portion has paired distal short medial longitudinal membranous lobes beset with denticles along margins, and paired outer lateral lobes are folded medially to the sides and are shorter than basal sclerotized portion of distal segment (Figure 12j). Cercus gradually curves ventrally (Figure 15l) and its tip is slightly upturned. Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16k). Male of *O. cultriformis* shares combination of hamule with outer branch bent ventrally over inner branch (Figure 10j) and epiproct apex relatively narrow, subapically less than 0.45 of its basal width (Figures 16k), only with *O. philipi*, *O. tambopatae*, and *O. teres*. It differs from *O. philipi* by pterothorax dark reddish brown to black with yellow stripes (Figure 2k) to entirely dark in mature males, inner and outer branches of hamule separated by a distance longer than length of inner branch (Figure 11j), and vesica spermalis distal segment rhomboidal in ectal view (Figure 13j), versus pterothorax marbled (Figure 2v), inner and outer branches of hamule separated by a distance shorter than length of inner branch (Figure 11q), and vesica spermalis distal segment parallel sided in ectal view, Figure 13r). Outer surface of outer branch of hamule is smooth in *O. cultriformis* (Figures 10j, 11j), but grooved *O. tambopatae* and *O. teres* (Figures 10s–t, 11t–u).

Female has labial palp with medial black stripe as wide as 0.33–0.40 of palp width, pterothorax reddish brown with yellow stripes, and abdomen narrowing gradually from S2 to S4, with S4 about as wide at level of apical carina as 0.35–0.46 of its length. Color of dorsal abdominal terga is similar to that of male. Ventrolateral flap on S8 is yellow, ca. 0.33–0.37 as wide as its length (Figure 17i). Vulvar lamina consists of a medial longitudinal ridge and an M-shaped transverse ridge, with transverse anterior bar sometimes with a pair of small points directed ventrally, and lateral ends projected posteriorly on each side (Figure 18k). Female shares a similar vulvar lamina with *O. aciculata*, *O. anthracina*, *O. cinnamomea*, *O. coracina*, *O. faaseni*, and *O. harpago*. Among them, it shares the transverse anterior ridge lacking lateral or anterior triangular projections only with *O. aciculata*; it differs from it by the lateral ends of the transverse ridge considerably projected posteriorly, almost reaching posterior margin of sternum of S8 (Figure 18k, versus not projected posteriorly considerably, Figure 18a–b).

Remarks

The illustrations of the vulvar lamina and flap of S8 included in von Ellenrieder (2009, pp. 372, 373, figures 16f, 18d) were based on a misidentified female of *O. aciculata*; illustrations from specimens of *O. cultriformis* collected in copula with males are provided here (Figures 17i, 18k).

Distribution and biology

Orthemis cultriformis is a widespread species, occurring from Costa Rica in Central America south to Paraguay and N Argentina in South America (Figure 21). It is found near streams, rivers, and temporary ponds and swamps in the forest.

Orthemis faaseni sp. nov.

Figures 1g, 4f, 6f, 7i, 8i, 9e, 10m, 11l, 12k, 13k, 14i, 15n, 16l, 17j, 18l, 19k–l, 20

Etymology

This species is named *faaseni* (noun in the genitive case) after Tim Faasen, who collected the first two specimens of this species that I examined and kindly allowed me to study and describe them.

Specimens examined

Total 2 ♂, 1 ♀. – Holotype ♂: Brazil, Rondônia State, Porto Velho (8°46' S, 63°54' W), 28 February 1922, leg. J.H. Williamson & J.W. Strohm [UMMZ]; 1 ♂, 1 ♀ paratypes (in copula), Peru, Loreto Dept., Tamshiyacu-Tahuayo Reserve, subcanopy within primary terra firme forest (4°21'38" S, 73°10'10" W), 19 February 2010, leg. TF [TF].

Description of male holotype

Head. Prementum black; labial palps pale yellow with medial black stripe as wide as 0.33 of palp width and anterior margin narrowly black to the sides (as in Figure 1g); labrum yellow margined with black; base of mandibles and clypeus yellow; ventral half of antefrons pale brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex metallic blue; occipital triangle dark reddish brown; rear of head dark reddish brown with two yellow spots behind eye. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax dark reddish brown, with anterior margin yellow. Pterothorax dark reddish brown to black, with diffuse whitish-blue pruinescence on dorsum and venter, and pale yellow stripes as follows (as in Figure 19k): wide stripe along posterior half of mesepimeron and stripe along posterior margin of metepimeron; venter of pterothorax brown with yellowish ill-defined medial longitudinal stripe along basal half, bifurcated into two diverging stripes on distal half. – Legs dark reddish brown, with tarsi and armature black; metafemur armed with 17 (left) to 18 (right) short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur (left hind tibia and tarsus missing). – Wings hyaline with amber apex. One cubito-anal crossvein in Fw and Hw; sectors of arculus stalked; arculus between Anx 2–3 but closer to Anx 2, midway on left Hw; Fw triangles crossed, Hw triangles free; Fw subtriangles with 3 cells; one bridge crossvein in Fw and Hw; left Fw discoidal field with 3 rows of cells at base to 6 rows at hind margin (right wing missing posterior portion), right Hw with 2 rows of cells at base increasing to 15 at hind margin (left wing missing posterior portion); 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 21 cells. Pt reddish brown, 4.3 long in Fw and 4.2 in Hw, overlying 5 (right) to 6 (left) cells in Fw, 5 (right) to 4 (left) cells in Hw. Anx: 17 in Fw, 14 (right) to 15 (left) in Hw; Pnx: 15 (right) to 14 (left) in Fw, 16 in Hw.

Abdomen. Sides linear in dorsal and ventral view (as in Figures 4f, 6f), with no evident constriction between S3 and S4, S4 about twice as long as wide (ratio apical width/length = 0.52). Dorsal terga black, S2–8 with mid-dorsal carina pale yellow and margined by medial longitudinal pale yellow stripe; S1–3 with ventrolateral longitudinal pale yellow stripe; caudal appendages black. Ventrolateral carina on S2 and basal half of 3 vestigial, on distal half of S3 and S4–5 absent (as in Figure 6f), on S6–8 well developed, on S9 incomplete, extending along basal 0.66 of segment. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (as in Figure 6f) dark reddish brown (S2–4) to black (S5–10), S1–2 with pale yellow stripe along ventrolateral carinae; S3–5 with yellow stripe along lateral margin on basal two thirds (S3) to basal half (S4–5) of segment. Anterior lamina in lateral view about a third of hamule height and about as high as genital lobe (as in Figure 10m); hamule bifid with longer inner branch forming pointed hook directed anteriorly, surpassing outer branch ventrally (as in Figure 11l); outer branch tip separated from inner branch by distance about as long as inner branch length (as in Figure 9e); outer corner of hamule outer branch rounded (as in Figure 11l). Distal segment of vesica spermalis with basal portion trapezoidal in ectal view, with sides parallel along basal half and converging to tip along distal half (Figure 13k), and with long flagella on ental surface; distal lobes represented on each side by subtriangular membranous outer lobe with transverse lateral fold, shorter than basal portion of distal segment in lateral view, and medial longitudinal sclerotized spatulate lobe longer than outer lobe, provided with a lateral longitudinal ridge, slightly expanded dorsoventrally at apex, and margined ventroapically with denticles (Figure 12k). Cercus markedly curved ventrally at base in lateral view, with row of 6 ventral tubercles along distal half and tip upturned (as in Figure 15m); in dorsal view about parallel sided to opposite cercus with tips converging (as in Figure 14i). Epiproct extending to 0.74 of cercus length, with apex slightly bifid and about as wide as 0.4 of its maximum width (as in Figure 16l).

Dimensions. Total length 42.15; abdomen length 27.4; Fw length 37; Hw length 35.7; Hw maximum width 10; cercus length 1.95; epiproct length 1.45; epiproct maximum width 1.

Variation in male paratype

Head. As for holotype but occipital triangle black.

Thorax. As for holotype but legs black, except for coxa and trochanter dark reddish brown; 19 + 1 metafemoral spurs; Fw subtriangle with 4 cells; Fw discoidal field with 8 rows of cells at hind margin, Hw with 14–15 at hind margin; anal loop enclosing 23–24 cells. Pt 4.4 in Fw, 4.3 in Hw; Anx: 19 in Fw, 13 in Hw; Pnx: 15 in Fw, 16 (left) to 18 (right) in Hw.

Abdomen. As for holotype but ventrolateral carina on S3 vestigial, and absent on S4–5 but its position indicated by row of denticles (Figure 6f); cercus with row of 5 ventral tubercles along distal half.

Dimensions ($n = 1$). Total length 42.5; abdomen length 27.7; Fw length 38.3; Hw length 36.2; Hw maximum width 9.8; cercus length 1.9; epiproct length 1.42; epiproct maximum width 1.

Average dimensions ($n = 2$). male total length 42.33 ± 0.12 ; abdomen length 27.55 ± 0.11 ; Fw length 37.65 ± 0.46 ; Hw length 35.95 ± 0.18 ; maximum Hw width 9.90 ± 0.07 ; cercus length 1.93 ± 0.02 ; epiproct length 1.44 ± 0.01 ; epiproct maximum width 1.00 ± 0.0 ; epiproct subapical width 0.45 ± 0.0 .

Variation in female paratype

Head. As for holotype but clypeus pale brown; antefrons yellow laterally, reddish brown medially; postfrons reddish brown; vertex reddish brown with metallic blue reflections; occipital triangle dark reddish brown; rear of head reddish brown.

Thorax. As for holotype but lacking any pruinescence; mesepisternum with yellow medial longitudinal stripe adjacent to mediodorsal carina and yellow longitudinal stripe parallel to mesepisternal–mesepimeral carina (Figure 19l); metafemur armed with 17 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings hyaline, with infumated apex; arcus between Anx 2–3 but midway in Hw; Fw discoidal field with 6 cells at hind margin, Hw with 15–16; anal loop enclosing 26 cells. Pt 4.6 long in Fw and 4.5 in Hw, overlying 5–6 cells in Fw and 6 cells in Hw. Anx: 18–19 in Fw, 15–16 in Hw; Pnx: 17–18 in Fw, 18 in Hw.

Abdomen. As for holotype but ratio S4 apical width/length = 0.53. Ventrolateral carina on S4–5 present, on S9 absent. Dorsal terga S1–8 with mid-dorsal carina pale yellow and margined by medial longitudinal pale yellow stripe; S1–7 with ventrolateral longitudinal pale stripe, yellow on S1–4, orange on S5–7 (Figure 19l). Ventrolateral flap on S8 dark reddish brown (Figure 19l). Vulvar lamina on S8 extending along posterior 0.32 of S8 length, consisting of medial longitudinal ridge anterior to posterior margin of sternum S8, with anterior corners projected anterolaterally and convex (Figure 18l).

Dimensions. Total length 43.4; abdomen length 27.8; Fw length 37.5; Hw length 36.2; maximum Hw width 9.8; ventrolateral flap on S8 length 3, width 0.85; ratio width/length 0.28; cercus length 1.3; epiproct length 0.55; epiproct maximum width 0.85.

Diagnosis

Male of *O. faaseni* differs from all known species of *Orthemis* by ventrolateral carina on S4–5 absent (Figures 4f, 6f) and distal segment of vesica spermalis with medial longitudinal sclerotized spatulate lobe longer than outer lobe (Figure 12k). Within the *levis* group, it approaches *O. harpago* by hamule shape, with inner branch longer than outer branch, forming a pointed hook directed anteriorly, surpassing outer branch ventrally (Figures 9e–f, 10m–n, 11l–m). It differs from *O. harpago* by narrower epiproct apex, as wide as 0.4 of epiproct maximum width (Figure 16l; versus as wide as 0.5–0.6 of maximum width, Figure 16o), abdomen narrowed gradually at base, with base of S4 more than half as high as base of S3 in lateral view (Figure 4f; versus narrowed abruptly, with base of S4 less than half as high as base of S3, Figure 4i), and S4 relatively shorter, with S4 width/length ratio of 0.52 (Figure 6f; versus longer, with S4 width/length ratio of 0.19–0.23, Figure 6i).

Female shares a similar vulvar lamina, characterized by the presence of a medial longitudinal ridge anterior to posterior margin of sternum S8, with *O. anthracina*, *O. aciculata*, *O. cinnamomea*, *O. coracina*, *O. cultriformis*, and *O. harpago*. Among them, it is most similar to *O. cinnamomea*, *O. coracina*, and *O. harpago* by the presence of triangular projections directed anterolaterally on the anterior ridge of vulvar lamina. It differs from *O. coracina* and *O. harpago* by the triangular projections being convex (Figure 18l; versus concave, Figures 18j, o), and from *O. cinnamomea* by S4 shorter and wider, with S4 length 4.3 mm and S4 apical width/length 0.53 (Figure 8i; versus S4 length 5.25–5.7 mm and S4 apical width/length 0.3–0.39, Figure 8l), S8 flap reddish brown (Figure 19l; versus whitish, Figure 19b), and abdomen narrowed gradually at base (Figure 7i; versus more abruptly, Figure 7l).

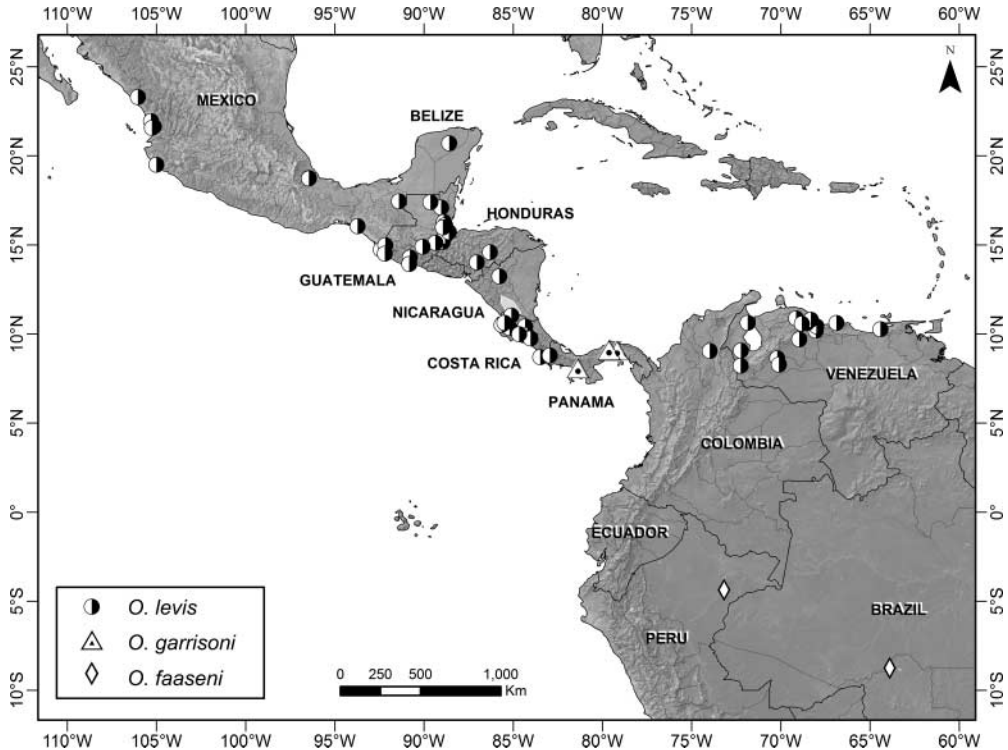


Figure 20. Distribution of *Orthemis levis*, *O. garrisoni*, and *O. faaseni*.

Distribution and biology

So far only known from W Brazil and N Peru (Figure 20). Male and female paratypes were found in copula along a stream within primary forest subcanopy in terra firme; a second male was photographed also in primary forest subcanopy in lower restinga (T. Faasen, personal communication).

Orthemis flavopicta Kirby, 1889

Figures 1h, 2l–o, 4g, 6g, 7j, 8j, 9g, 10k, 11o, 12l, 13l, 14j, 15n–o, 16m, 17k, 18m, 19m–n, 23

Orthemis flavopicta Kirby, 1889 (p. 332, plate LIV: figure 1; plate LVII: figure 5; in part, except female; description, color illustration of a syntype male, outline illustration of caudal appendages); Calvert (1899, p. 33, possibly in part; inclusion in key); Ris (1910, p. 290, in part; inclusion in key); Kimmins (1969, p. 286; designation of male lectotype from Pará, Brazil, in BMNH); Garrison (1984, p. 48, figures 1, 3, in part; illustration of thorax and hamule of paralectotype male and of male from Jatui, Goiás State, Brazil).

Type specimens examined

Lectotype ♂: Brazil, “Pará” [BMNH]. Paralectotypes: 3 ♂ same data as lectotype [BMNH].

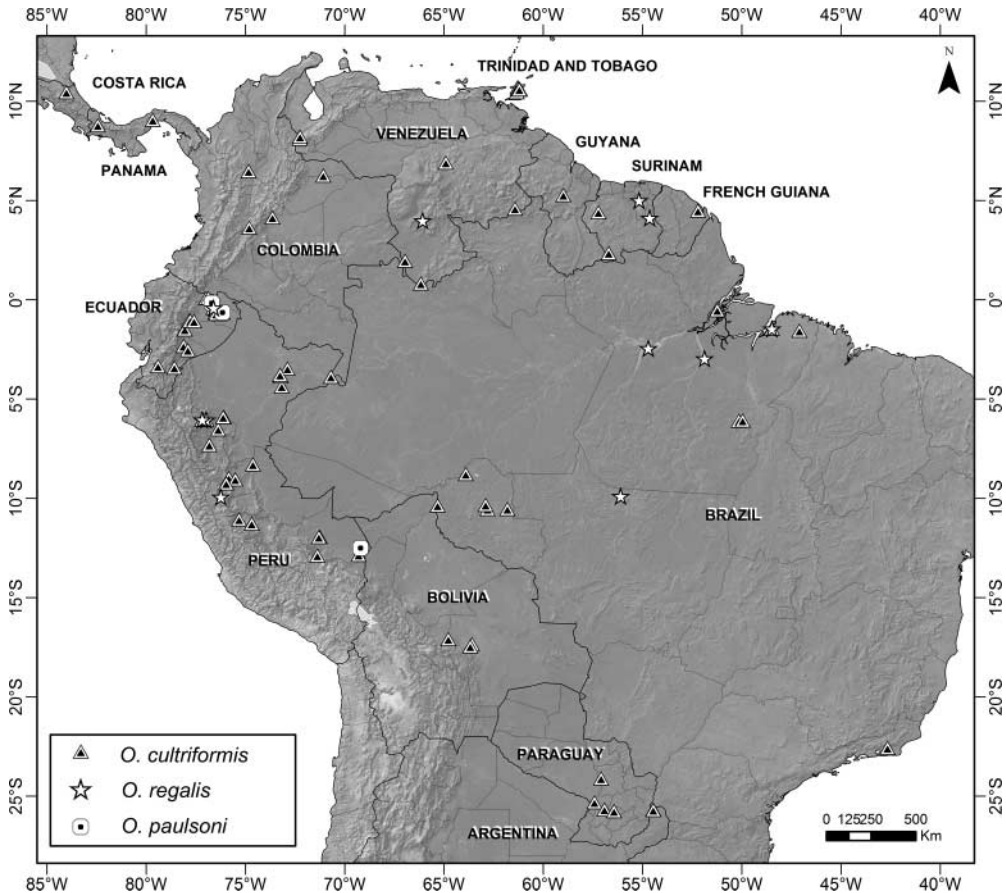


Figure 21. Distribution of *Orthemis cultriformis*, *O. regalis*, and *O. paulsoni*.

Other specimens examined

Total 10 ♂, 2 ♀. – 1 ♂, Venezuela, Bolívar State, km 17 south of El Dorado (6°36'5" N, 61°34'57" W), 29 June 1984, leg. J. Nation [FSCA]; 1 ♂, same but [RWG]; 1 ♂, same but 28 June 1984, leg. P.J. Eliazar [FSCA]; 1 ♂, Brazil, Pará State, "Pará", 08 December 1892, from O. Staudinger [UMMZ]; 1 ♂ [missing S1–3], same but 21 November 1892 [UMMZ]; 1 ♀, same but 25 November 1892, from O. Staudinger [UMMZ]; 1 ♂, Brazil, Rondônia State, 2 km N Cacauplandia on B-65, línea C-17, Austin trail (10°19'25" S, 62°54'0" W), 15 November 1991, leg. M. J. Westfall, Jr. [FSCA]; 1 ♂ paratype, same but dry trail, 16 November 1991 [FSCA]; 1 ♂ paratype, Brazil, Bahia State, K13, Encontro das Aguas, Lauro de Freitas (12°51'47" S, 38°18'50" W), 29 May 2007, leg. R. Penalva [RWG]; 1 ♂, 1 ♀ paratypes, same but 18 October 2011 [RWG]; 1 ♂ paratype [missing S7–10], Brazil, Goiás State, Jataí (17°52'60" S, 51°43'0" W), January 1955, leg. A.B.M. Machado [RWG]; 1 ♂, Bolivia, Santa Cruz Department, Velasco Province, La Estrella, 24 km N on highway to La Florida, Río San Martín (15°23'61" S, 61°29'77" W), 12 November 1999, leg. W. Mauffray [FSCA].

Redescription of male lectotype

Head. Prementum black; labial palps pale yellow with medial black stripe as wide as 0.40 of palp width and anterior margin narrowly black to the sides (Figure 1h); labrum black with pair

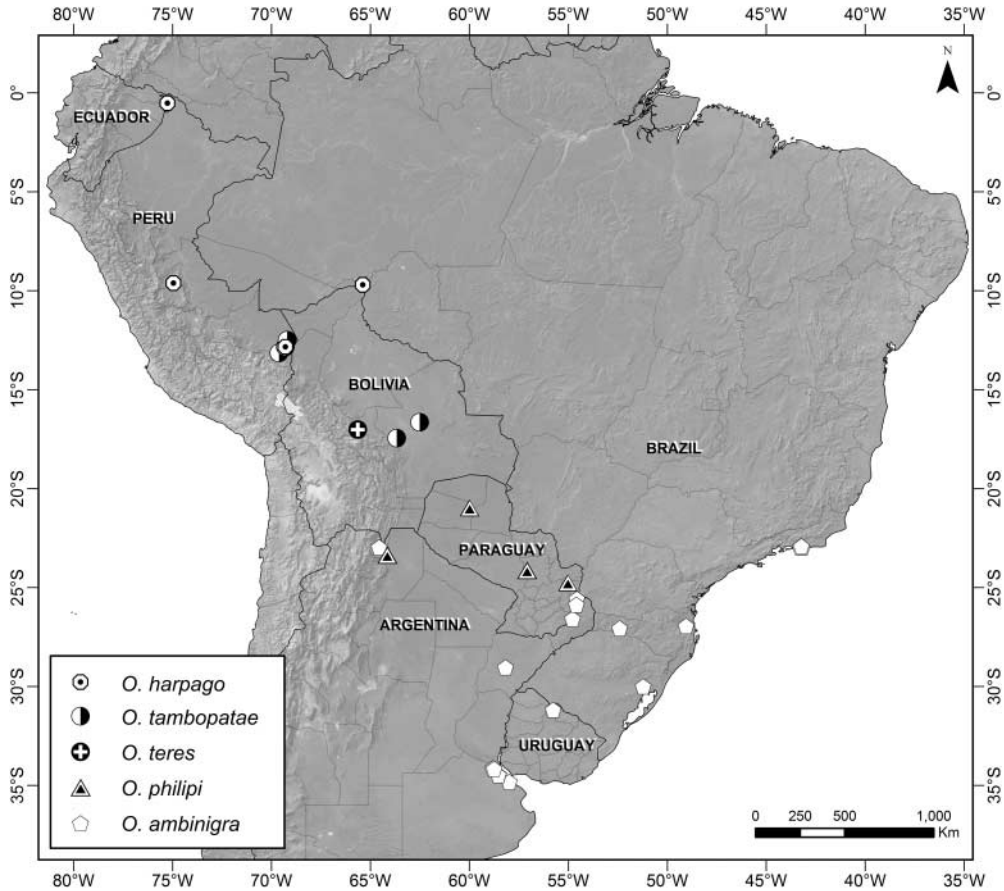


Figure 22. Distribution of *Orthemis harpago*, *O. tambopatae*, *O. teres*, *O. philipi*, and *O. ambinigra*.

of rounded laterobasal pale yellow spots; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, anteclypeus pale brown to pale yellow along clypeal suture, postclypeus pale brown with medial dark brown spot and postclypeal lobes narrowly fringed with dark brown line along distal margin; ventral half of antefrons pale brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex metallic blue with purple reflections, occipital triangle pale reddish brown, rear of head reddish brown. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax dark reddish brown. Pterothorax dark brown with yellow stripes as follows: medial longitudinal stripe adjacent to mediodorsal carina; longitudinal stripe parallel to mediodorsal carina at mesepisternum mid width (as in Figure 2m); stripe along posterior half of mesepimeron narrowing dorsally; stripe along ventral margin of metepisternum and another sinuous one ventral to metastigma, and oval spot on posterodorsal corner; metepimeron with stripe along posterior half, narrowing dorsally, and subtriangular spot on anterodorsal corner (Figure 2l); venter of pterothorax brown with pale yellow medial longitudinal stripe along basal half, bifurcated into two diverging stripes on distal half. – Legs with coxa pale yellow, trochanter of foreleg pale yellow, of middle and hind leg reddish brown; femur of foreleg pale yellow along posterior half, remainder reddish brown, of middle and hind leg reddish brown; tibia dark reddish brown;

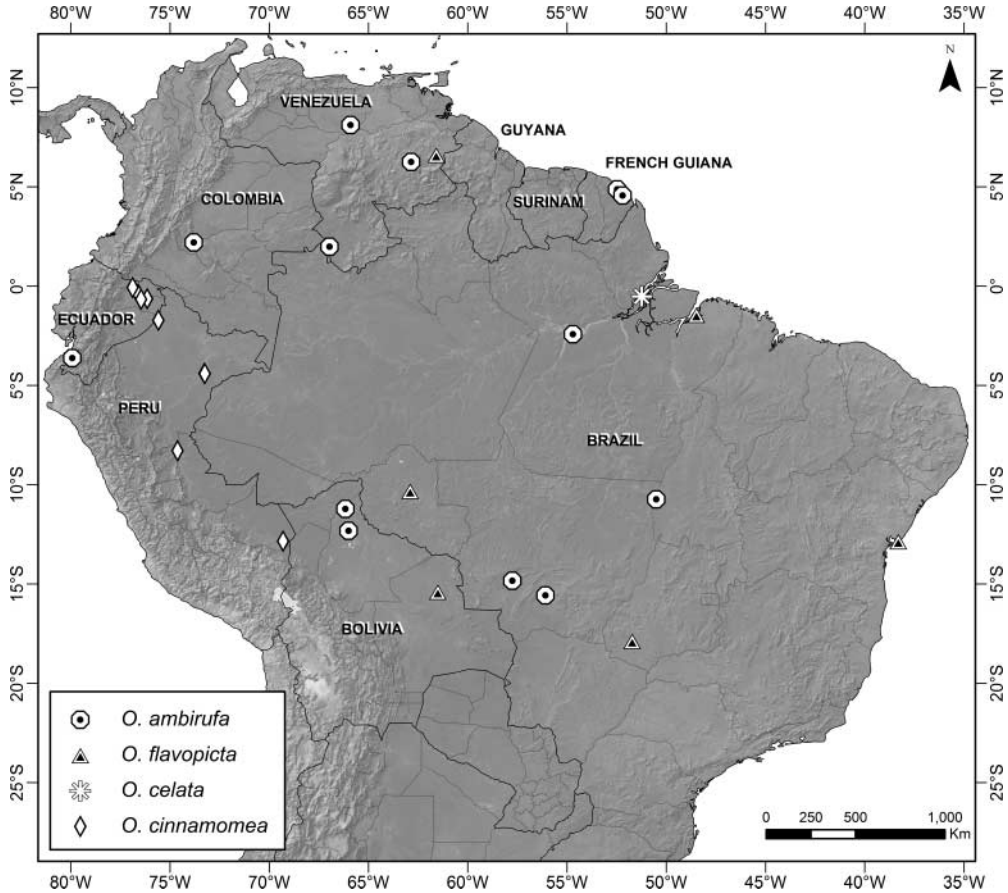


Figure 23. Distribution of *Orthemis ambirufa*, *O. flavopicta*, *O. celata*, and *O. cinnamomea*.

tarsus, pretarsus, and spines black; metafemur armed with 19 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings hyaline with tip amber from level of distal end of pterostigma to apex. One cubito-anal crossvein in Fw and HW; sectors of arculus stalked; arculus between Anx 2–3 but closer to Anx 2 in right FW, opposite to Anx 2 in left FW, midway between Anx 2–3 in HW; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 5 rows at hind margin, Hw with 3 rows of cells at base, then 2, then increasing to 15 at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 27 cells. Pt reddish brown, 5.0 long in Fw and 4.9 in Hw, overlying 6 cells in Fw and 5 cells in Hw. Anx: 17 in Fw, 14 (right) and 15 (left) in Hw; Pnx: 15 (right) and 17 (left) in Fw; 17 in Hw.

Abdomen. Sides linear, parallel sided in dorsal and ventral view (Figures 4g, 6g), with no evident constriction between S3 and S4, S4 almost two times as long as wide (ratio apical width/length = 0.53). S1–7 dorsal terga dark reddish brown (S1–4) to dark brown (S5–7) with mid-dorsal carina pale yellow and margined by medial longitudinal pale yellow stripe, and ventrolateral longitudinal pale yellow (on S1–3) to pale orange (on S4–7) stripe; S8 black with ventrolateral longitudinal pale orange stripe; S9–10 black; caudal appendages dark reddish brown. Ventrolateral carina on S2 vestigial, on S3–9 well developed and black, on S9 incomplete, extending along basal 0.75 of

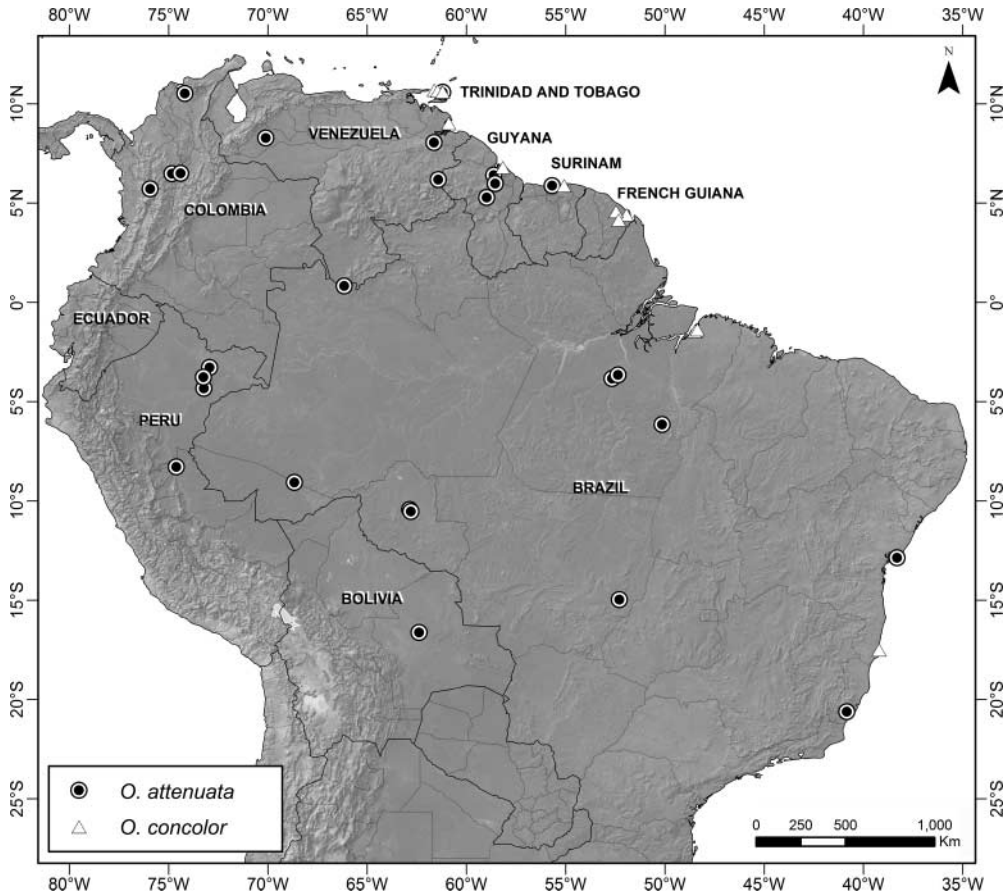


Figure 24. Distribution of *Orthemis attenuata* and *O. concolor*.

segment. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 6g): S1 and S2 reddish brown with yellow along ventrolateral carinae; S3–4 reddish brown, S5–8 dark reddish brown, with yellowish stripe along lateral margin on basal two thirds of segment; S9–10 dark reddish brown. Anterior lamina in lateral view slightly shorter than hamule and about as high as genital lobe (Figure 10k); right hamule (left hamule missing) bifid with small inner branch forming short pointed spine directed posteriorly, in the same plane as and larger than outer branch; tip of outer branch separated from inner branch by distance about as long as inner branch length; outer corner of hamule roundly angled (Figure 11o). Distal segment of vesica spermalis with basal portion parallel sided in ectal view (Figure 13l), and with pair of long flagella on ental surface; distal portion represented on each side by outer lobe, with sclerotized subtriangular part about as long as basal portion of distal segment in lateral view, folded medially into transverse membranous part, approximately oval in ectal view, as long as half of basal portion or shorter, and medioectal sclerotized lobe with medial ridge margined with denticles laterally; medioectal lobe about as long as half the length of outer lobe (Figure 12l). Right cercus (left cercus missing) in lateral view markedly curved ventrally at base and with tip not upturned; distal dilated portion with row of 6 ventral tubercles along its base (Figure 15n); in dorsal view converging along basal 0.66 with opposite cercus, then approximately parallel to it along distal 0.33 (Figure 14j). Epiproct extending to 0.77 of cerci length, with apex entire and about as wide as a third of its basal width (wooden probe inserted in abdomen precludes an exact measurement).

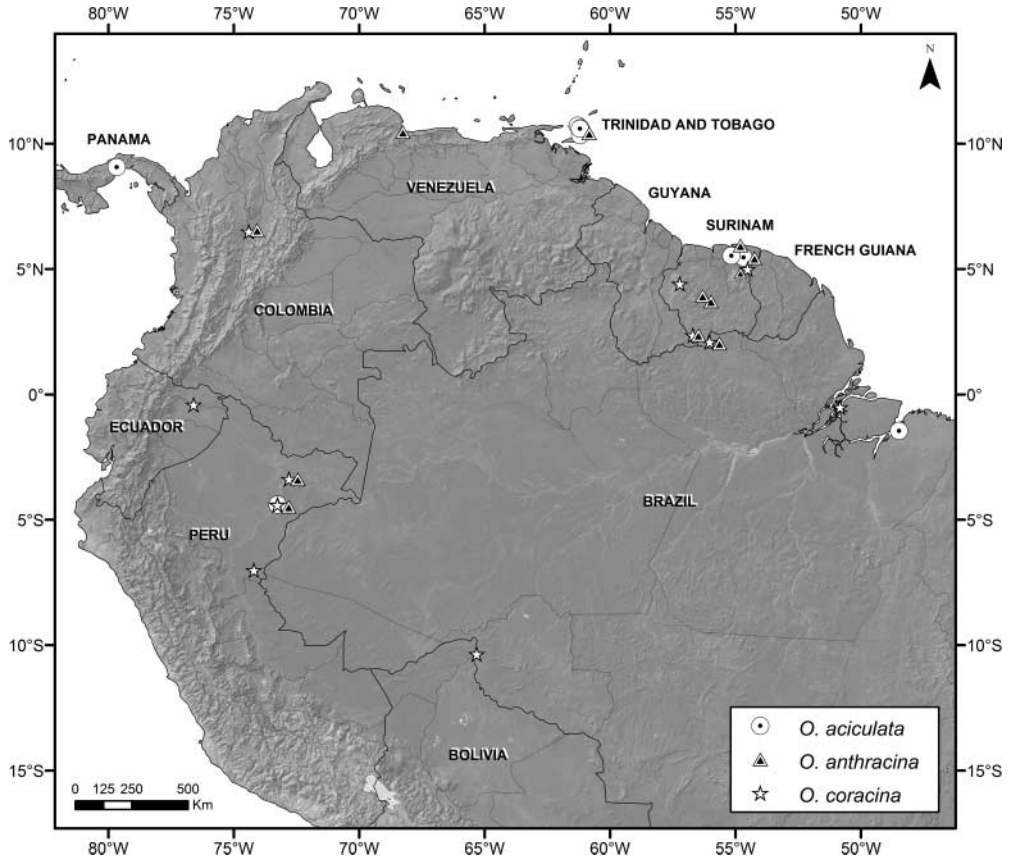


Figure 25. Distribution of *Orthemis coracina*, *O. anthracina*, and *O. aciculata*.

Dimensions. Total length 50.1; abdomen length 32; Fw length ca. 41 (apical cells missing); Hw length 36.97; Hw maximum width 11.5; cercus length 2.2; epiproct length 1.7; epiproct maximum width 1.2.

Variation in males

Head. As for lectotype but labial palp medial black stripe as wide as 0.3–0.4 of palp width; postclypeus pale brown with postclypeal lobes narrowly fringed with dark brown line along distal margin in one male; frons and vertex metallic purple lacking blue reflections in one male, and metallic blue lacking purple reflections in two males; occipital triangle dark reddish brown to reddish brown dorsally, yellow posteroventrally; rear of head reddish brown, with two yellow spots behind eye.

Thorax. As for lectotype but prothorax reddish brown with anterior margin of anterior lobe pale; yellow longitudinal stripe parallel to mesepisternal–mesepimeral carina confluent at anterior 0.20 to narrow yellow stripe along mesepisternal–mesepimeral carina in one paratype; bluish white pruinescence on mesepisternum and venter of pterothorax in two males; mesepisternum entirely covered by pruinescence rendering pale stripes invisible in some paratypes (Figures 2n, 19m); metafemur armed with 16–19 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur; Fw subtriangles with 3 cells in one wing, with 5 cells

in one wing; Fw discoidal field with 3–4 rows of cells at base to 4–7 rows at hind margin, Hw with 3 rows of cells at base, then 2, then increasing to 13–18 at hind margin; anal loop enclosing 21–27 cells. Pt overlying 4–6 cells in Fw and Hw. Anx: 15–19 in Fw, 12–14 in Hw; Pnx: 13–17 in Fw, 14–18 in Hw.

Abdomen. As for holotype but bluish white pruinescence on sides of genital lobe and hamule in two males; dorsal terga S1–10 background dark reddish brown to black; distance between medial margin of hamule inner branch and medial margin of hamule outer branch variable (Figures 10k, 11o), depending on degree of contraction of area that remains membranous on inner surface between outer and inner branches (Figure 11o); ratio apical width/length S4 = 0.37–0.54; cercus with row of 5–8 ventral tubercles along distal half; epiproct extending to 0.74–0.8 of cerci length.

Dimensions ($n = 9$). Male total length 45.6–50.8; abdomen length 28.7–32.5; Fw length 37.2–41.2; Hw length 36–39; maximum Hw width 10.2–11.2; Fw Pt length 4.8–5.4; Hw Pt length 4.5–5.1; cercus length 2.05–2.35; epiproct length 1.6–1.85; epiproct maximum width 0.95–1.15; epiproct subapical width 0.3–0.4.

Average dimensions ($n = 10$). Male total length 48.83 ± 1.58 ; abdomen length 31.24 ± 1.34 ; Fw length 39.37 ± 1.31 ; Hw length 38 ± 0.92 ; maximum Hw width 10.96 ± 0.35 ; cercus length 2.17 ± 0.07 ; epiproct length 1.71 ± 0.08 ; epiproct maximum width 1.05 ± 0.06 ; epiproct subapical width 0.37 ± 0.03 .

Variation in females

Head. As for lectotype but labrum yellow margined with black; palp medial black stripe as wide as 0.33–0.4 of palp width; dorsal portion of antefrons, postfrons, and vertex pale brown; occipital triangle dark brown; rear of head dark reddish brown with two yellow spots behind eye.

Thorax. As for lectotype (Figure 2o); metafemur armed with 13–15 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings hyaline except for infumated apex; Fw discoidal field with 3 rows of cells at base to 5–6 rows at hind margin, Hw with 3 rows of cells at base, then 2, then increasing to 14–17 at hind margin; anal loop enclosing 21–23 cells. Pt overlying 5–6 cells in Fw and Hw. Anx: 14–17 in Fw, 12–14 in Hw; Pnx: 13–16 in Fw, 13–18 in Hw.

Abdomen. As for lectotype but ventrolateral carina on S9 absent; dorsal tergum S8 black with mediodorsal carina narrowly yellow; ventrolateral flap on S8 pale yellow (Figure 19n). Vulvar lamina extending along posterior 0.20 of S8 length, forming three-dimensional raised ridge shaped as an inverted U, rounded in cross-section (Figure 18m). Caudal appendages dark reddish brown.

Dimensions ($n = 2$). Total length 47.9–52; abdomen length 31.3–34.5; Fw length 39.1–42; Hw length 37.7; maximum Hw width 10.8–11; Pt length in Fw 5.2, in Hw 4.8–5; S4 apical width/length 0.4–0.41; ventrolateral flap on S8 length 3.2–3.25, width 0.7–0.85; ratio width/length 0.21–0.26; epiproct length 0.45–0.5; epiproct maximum width 0.85–1.2.

Diagnosis

Male of *O. flavopicta* shares combination of a dark reddish brown to black abdomen with narrow medial longitudinal and ventrolateral yellow stripes on S4–7 and gradually narrowing at base,

epiproct narrow at apex, and hamule with inner and outer branches in about the same plane only with *O. garrisoni* and *O. regalis*. It can be distinguished from *O. garrisoni* by the medioectal distal lobe of vesica spermalis bearing a sclerotized ridge covered with minute spines (Figure 12l; versus bearing a strong sclerotized lateral spine in *O. garrisoni*, Figure 12m). It differs from *O. regalis* by wings lacking dark markings along C-RA space, smaller size (Hw < 45 mm), presence of three rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop, outer corner of outer branch of hamule not triangular and projected ventroposteriorly in lateral view (Figure 10k), and basal sclerotized portion of vesica spermalis ca. parallel sided in ectal view (Figure 13l); versus wings with dark markings on C-RA space, larger size (Hw > 50 mm), four rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop, outer corner of outer branch of hamule triangular and projected ventroposteriorly in lateral view (Figure 10r), and basal sclerotized portion of vesica spermalis deeply constricted medially in ectal view (Figure 13q) in *O. regalis*.

Female shares a similar vulvar lamina consisting of an inverted U-shaped ridge anterior to posterior margin of S8 with females of *O. ambinigra* and *O. garrisoni*. It differs from *O. ambinigra* by the ridge being swollen, rounded in cross-section (Figure 18m; versus thin and laminar, Figure 18c), and from *O. garrisoni* by the narrower transverse bar of the inverted “U” ridge, shorter than the longitudinal arms of the ridge (Figure 18m; versus wider transverse bar of the inverted “U” ridge, as long as the longitudinal arms of the ridge, Figure 18n).

Remarks

Orthemis flavopicta Kirby, 1889 was described based on a series of four males and one female from “Pará”, with no further data. Kimmins (1969) designated the male bearing Kirby’s type label as lectotype but did not provide any descriptive notes for it. Kirby’s (1889) description stated that the epiproct was “broad and bifid, or rather crescent-shaped at the apex”; however, examination of the type series shows the epiproct to be narrow at tip in all four males. All type specimens have been preserved with a thin piece of wood inserted through the abdomen and extruding from sternum S8 blocking a full ventral view of caudal appendages. The lectotype has a partially crushed mesepisternum, for which reason I selected a paralectotype male to illustrate the dorsal view of the thorax. Vesica spermalis of lectotype was extracted and placed on a separate pin by Buchholz, and I extruded the vesica spermalis – without detaching it – from all paralectotypes as well for comparison. I believe that the female included by Kirby in the type series of *O. flavopicta* does not correspond to this species, because it differs from females found flying together with males of *O. flavopicta* in both Pará and Bahia which closely match the male of *O. flavopicta* based on color pattern and size. Kirby’s female instead agrees well with females of *O. aciculata* found flying with males of that species in Trinidad and Surinam.

Examination of the lectotype of *O. flavopicta* showed that specimens from Panama identified and depicted as *O. flavopicta* in Garrison (1984) and von Ellenrieder (2009) correspond in fact to a different species (see under *O. garrisoni*). I found specimens of *O. aciculata*, *O. anthracina*, *O. coracina*, *O. cultriformis*, and *O. garrisoni* that were misidentified as *O. flavopicta* by different authors, including Calvert; however, I was not able to revise all the specimens studied by this author in order to conclude if he had any bona fide *O. flavopicta* available for study in his treatment of this group (Calvert 1899), and consequently I list his publication including this species in the synonymic list as “possibly in part”.

Seemingly only in *O. flavopicta* does the membranous area on inner surface of hamule extend along the entire height of the hamule (Figure 11o); in all the specimens of other species that I examined, the area that remains membranous seems to be limited to the distal portion of inner surface of the hamule, between inner and outer branches, and the degree of intraspecific variability

of the distance between both branches and their position relative to the base of the hamule is very low in comparison to that observed in *O. flavopicta*.

Distribution and biology

Orthemis flavopicta occurs from Bolívar State in S Venezuela and N Brazil south to central Brazil and Bolivia (Figure 23), in forested rivers and trails.

Orthemis garrisoni sp. nov.

Figures 1i, 2p–q, 4h, 6h, 7k, 8k, 10l, 11p, 12m, 13m, 14k, 15p, 16n, 17l, 18n, 19o, 20

Orthemis flavopicta nec Kirby, 1889 – Garrison (1984, p. 48, figures 2, 4, in part; illustrations of male pterothorax and hamule; misidentification of males from Panama); Donnelly (1992, p. 89; misidentification of male from Panama); von Ellenrieder (2009, pp. 350, 375, 380, figures 8j, 9i, 11e, 14i, 15i, 20, table 1; illustrations of hamule, vesica spermalis, S10, map, inclusion in key; misidentification of male from Panama).

Etymology

This species is named *garrisoni* (noun in the genitive case) after my dear husband Rosser W. Garrison, who collected the first specimens of this species which I was able to examine, in recognition of his constant support to all students of neotropical odonates and his numerous outstanding contributions to the knowledge of New World odonate taxonomy.

Specimens examined

Total 14 ♂, 2 ♀. – Holotype ♂: Panama, Panamá Prov., 7 km NW of Gamboa, Pipeline road, trail near palm forest, 30 July 1979, leg. RWG & J.A. Garrison [FSCA]; 2 ♂ paratypes, same as holotype [RWG]; 1 ♂ paratype, same but [FSCA]; 3 ♂ paratypes, same as holotype but trail at milepost 12, by Gaillard highway, 7.4 km SE of Gamboa, 03 August 1979 [RWG]; 1 ♂ paratype, same but [DRP]; 1 ♂ paratype, same but [FSCA]; 1 ♂ paratype, same but 4 August 1979 [RWG]; 1 ♂ paratype, same but stream 2.2 km NW of Gamboa, 7 August 1979 [RWG]; 1 ♂ paratype, Panama, Panamá Prov., La Pita (9°4'0" N, 79°40'0" W, 75 m), 20 June 196, leg. H.G. Real [RWG]; 1 ♂ paratype, Panama, Panamá Prov., 6 km E Pacora, Hacienda San José (9°4'57" N, 79°14'10" W), 29 August 1972, leg. M. Perrone [DRP]; 1 ♂, 1 ♀ (in copula) paratypes, Panama, Veraguas Prov., Corozal (8°4'56" N, 81°26'11" W), 22 May 1937, leg. R. Bliss [FSCA]; 1 ♀ paratype, same but 20 June 1936 [RWG].

Description of male holotype

Head. Prementum black; labial palps pale yellow with medial black stripe as wide as 0.33 of palp width anteriorly extending to the sides along almost entire anterior margin of palp (Figure 1i); labrum black with pair of rounded laterobasal pale yellow spots; base of mandibles yellow; lateral portion of clypeus along eyes whitish, anteclypeus pale brown, postclypeus pale brown with medial dark brown spot and postclypeal lobes narrowly fringed with dark brown line along distal margin; ventral half of antefrons pale brown medially and whitish laterally, dorsal portion of antefrons, postfrons, and vertex metallic blue with purple reflections, occipital triangle dark reddish brown, rear of head reddish brown, with two yellow spots behind eye. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown with anterior lobe anterior margin pale yellow and medial lobe covered with bluish white pruinescence. Pterothorax dark reddish brown, with mesepisternum, antealar sinus, and terga covered with bluish white pruinescence, and pale yellow stripes as follows (Figure 2p): diffuse mesepisternal stripe adjacent to mesepisternal–mesepimeral carina; wide stripe along posterior half of mesepimeron narrowing dorsally; narrow stripe ventral to metastigma, and oval spot on posterodorsal corner; metepimeron with stripe along posterior margin and subtriangular spot on anterodorsal corner; venter of pterothorax brown with yellowish ill-defined medial longitudinal stripe along basal half, bifurcated into two diverging stripes on distal half. – Legs with base of coxa pale yellow, apical portion of coxa, trochanter, and posterior surface of fore and mid leg pale reddish brown, remainder dark reddish brown; tarsus, pretarsus, and spines black; metafemur armed with 22 (right) or 18 (left) short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings deeply infumated in gold. One cubito-anal crossvein in Fw and HW; sectors of arcus stalked; arcus between Anx 2–3 but closer to Anx 2; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 6 rows at hind margin, Hw with 3 rows of cells at base, then 2, then increasing to 18 at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 23 (right) or 25 (left) cells. Pt reddish brown, 5.4 long in Fw and 5 in Hw, overlying 6 (right) or 5 (left) cells in Fw and 4 (right) or 5 (left) cells in Hw. Anx: 16 (right) and 17 (left) in Fw, 13 (right) and 14 (left) in Hw; Pnx: 16 in Fw, 16 in Hw.

Abdomen. Sides almost parallel in dorsal and ventral view (Figures 4h, 6h), with no evident constriction between S3 and S4, S4 two times as long as wide (ratio apical width/length = 0.5). S1–7 dorsal terga dark reddish brown (S1–4) to dark brown (S5–7) with mid-dorsal carina pale yellow and margined by medial longitudinal pale yellow stripe, and ventrolateral longitudinal pale yellow stripe; S8 black with ventrolateral longitudinal pale yellow stripe; S9–10 black; caudal appendages dark reddish brown. Ventrolateral carina on S2 vestigial, on S3–9 well developed and black, on S9 incomplete, extending along basal 0.66 of segment. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 6h): S1 and S2 reddish brown with yellow along ventrolateral carinae; S3–4 reddish brown, S5–8 dark reddish brown, with yellowish stripe along lateral margin on basal two thirds of segment; S9–10 dark reddish brown. Anterior lamina in lateral view slightly shorter than hamule and about as high as genital lobe (Figure 10l); hamule bifid with smaller inner branch forming short pointed spine directed posteriorly, in the same plane as larger outer branch; outer branch tip separated from inner branch by distance about as long as inner's branch length; outer corner of hamule roundly angled (Figure 11p). Distal segment of vesica spermalis with basal portion parallel sided in ectal view (Figure 13m), and with pair of long flagella on ental surface; distal portion represented on each side by outer lobe, with sclerotized oval portion about as long as basal portion of distal segment in lateral view, folded medially into transverse membranous portion, approximately oval in ectal view, as long as half of basal portion or shorter, and medioectal sclerotized lobe with strong lateral spine directed anteroventrally on each side; medioectal lobe about as long as 0.75 of the length of outer lobe (Figure 12m). Cercus in lateral view markedly curved ventrally at base and with tip slightly upturned; distal dilated portion with row of 7 ventral tubercles along its base (Figure 15p); in dorsal view converging along basal 0.66 with opposite cercus, then approximately parallel to it along distal 0.33 (Figure 14k). Epiproct extending to 0.78 of cerci length, with apex entire and about as wide as a third of its basal width (Figure 16n).

Dimensions. Total length 53.9; abdomen length 35.1; Fw length 42.1; Hw length 41.2; Hw maximum width 12.6; cercus length 2.35; epiproct length 1.85; epiproct maximum width 1.25.

Variation in male paratypes

Head. As for holotype but medial black stripe on labial palp as wide as 0.3 of palp width in four paratypes; lateral portion of clypeus along eyes, ventral half of antefrons laterally, and postclypeus along clypeal–frontal suture pale yellow in two paratypes; vertex with yellow spot from ocellus to medial line across posterior surface in one paratype; occipital triangle with pair of yellow spots posteroventrally in one paratype.

Thorax. As for holotype but mesepisternum with narrow medial longitudinal stripe adjacent to mediodorsal carina visible in one paratype, and with narrow longitudinal pale yellow stripe parallel to mediodorsal carina at mesepisternum mid width visible in five males with weak pruinescence; metafemur armed with 14–23 short spurs which slightly and gradually increase in size towards apex, followed distally by one, or rarely two, longer spurs. – Wings infumated only slightly in some paratypes; arculus between Anx 2–3 but midway in some wings; Fw discoidal field with 3 rows of cells at base to 4–7 rows at hind margin, Hw with 3 rows of cells at base, then 2, then increasing to 14–33 at hind margin; anal loop enclosing 20–24 cells. Pt overlying 5–7 cells in Fw and 4–6 cells in Hw. Anx: 16–19 in Fw, 13–15 in Hw; Pnx: 14–17 in Fw, 15–18 in Hw.

Abdomen. As for holotype but with slight constriction between S3 and S4 in three paratypes; apical width/length S4 0.31–0.56; tip of outer branch of hamule separated from tip of inner branch by distance shorter than inner branch length in five paratypes (Figure 11p); S9–10 reddish brown laterally in two males; with row of 6–8 ventral tubercles along distal half of male cercus; tip of cercus not upturned in three paratypes.

Dimensions ($n = 9$). Male total length 49.0–54.6; abdomen length 31.5–35.8; Fw length 40.1–43.0; Hw length 38.5–41.4; maximum Hw width 11.1–11.8; Pt Fw length 4.8–5.3; Pt Hw length 4.6–5.0; cercus length 2.05–2.30; epiproct length 1.60–1.85; epiproct maximum width 1.10–1.25; epiproct subapical width 0.40–0.45.

Average dimensions ($n = 10$). Male total length 52.24 ± 1.75 ; abdomen length 33.98 ± 1.38 ; Fw length 41.46 ± 0.97 ; Hw length 39.94 ± 1.06 ; maximum Hw width 11.52 ± 0.44 ; cercus length 2.22 ± 0.09 ; epiproct length 1.74 ± 0.08 ; epiproct maximum width 1.15 ± 0.07 ; epiproct subapical width 0.41 ± 0.02 .

Variation in female paratypes

Head. As for holotype but labrum reddish brown with black anterior margin and a pair of lateral pale yellow spots; postclypeus yellow with postclypeal lobes narrowly fringed with a brown line along distal margin; antefrons yellow laterally, reddish brown medially; postfrons reddish brown with a small yellow rounded spot anterolateral to base of antenna, vertex reddish brown, dark reddish brown around lateral ocellus, with a yellow spot from ocellus to medial line across posterior surface; occipital triangle reddish brown dorsally, yellow posteroventrally.

Thorax. As for holotype but lacking any bluish white pruinescence; mesepisternum with yellow medial longitudinal stripe adjacent to mediodorsal carina and yellow longitudinal stripe parallel to mesepisternal–mesepimeral carina confluent at anterior 0.20 to narrow yellow stripe along mesepisternal–mesepimeral carina (Figure 2q); metafemur armed with 12–17 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings hyaline, with infumated apex; arculus between Anx 2–3 but midway in some Hw; Fw discoidal field with 3 rows of cells at base to 5–7 rows at hind margin, Hw with 3 rows of cells at base,

then 2, then increasing to 15–17 at hind margin; anal loop enclosing 20–23 cells. Pt overlying 5–6 cells in Fw and 4–6 cells in Hw. Anx: 16–17 in Fw, 12–13 in Hw; Pnx: 14–15 in Fw, 15–16 in Hw.

Abdomen. As for holotype but ventrolateral carina on S9 absent. Ventrolateral flap on S8 pale yellow (Figure 17l). Vulvar lamina extending along posterior 0.20 of S8 length, consisting of an inverted U-shaped ridge, three-dimensional, rounded in cross-section (Figure 18n), with transverse bar of the inverted U-shaped ridge as long as longitudinal arms of the ridge. Appendages dark reddish brown.

Dimensions ($n = 2$). Total length (without appendages, cerci missing) 51.3–52; abdomen length 36; Fw length 42.7–43; Hw length 41–41.2; maximum Hw width 11–11.5; Pt Fw length 5.2–5.4, Pt Hw length 4.9–5.1; S4 apical width/length 0.45; ventrolateral flap on S8 length 3.15–3.40, width 0.9–1.0; ratio width/length 0.28–0.29; epiproct length 0.55; epiproct maximum width 1.1.

Remarks

This species was misidentified as *O. flavopicta* by Garrison (1984) and von Ellenrieder (2009); diagnostic characters of vesica spermalis, hamule, and vulvar lamina of the type series of *O. flavopicta* differ from those in this species, which is described here as *O. garrisoni*.

Diagnosis

Male of *O. garrisoni* shares combination of a dark reddish brown to black abdomen with narrow medial longitudinal and ventrolateral yellow stripes on S4–7, gradually narrowing at base (Figure 19o), epiproct narrow at apex, and hamule with inner and outer branches in about the same plane only with *O. flavopicta* and *O. regalis*. It can be distinguished from *O. flavopicta* by its medioectal distal lobe of the vesica spermalis bearing a strong sclerotized lateral spine (Figure 12m; versus bearing a sclerotized ridge covered with minute spines in *O. flavopicta*, Figure 12l). It differs from *O. regalis* by wings lacking dark markings along C-RA space, smaller size (Hw < 45 mm), presence of three rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop, outer corner of outer branch of hamule not triangular and projected ventroposteriorly in lateral view (Figure 10l), and basal sclerotized portion of vesica spermalis ca. parallel sided in ectal view (Figure 13m); versus wings with dark markings on C-RA space, larger size (Hw > 50 mm), four rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop, outer corner of outer branch of hamule triangular and projected ventroposteriorly in lateral view (Figure 10r), and basal sclerotized portion of vesica spermalis medially constricted in ectal view (Figure 13q) in *O. regalis*.

Female shares a similar vulvar lamina consisting of an inverted U-shaped ridge located slightly anterior to posterior margin of S8 separated from it by its own length or less only with *O. ambinigra* and *O. flavopicta*. It differs from *O. ambinigra* by the ridge forming a three-dimensional lip rounded in cross-section (Figure 18n; versus laminar, Figure 18c), and from *O. flavopicta* by the wider transverse bar of the inverted U-shaped ridge, as long as the longitudinal arms of the ridge (Figure 18n; versus narrower transverse bar of the inverted U-shaped ridge, shorter than the longitudinal arms of the ridge, Figure 18m).

Distribution and biology

This species is so far known only from Panama (Figure 20), where adults were found along forested streams and trails. It seems to be the northern counterpart to its nearest ally, *O. flavopicta*, being allopatric with that species.

***Orthemis harpago* von Ellenrieder, 2009**

Figures 2r–s, 4i, 6i, 7l, 8l, 9f, 10n, 11m, 12n, 13n, 14l, 15q, 16o, 17m, 18o, 22

Orthemis harpago von Ellenrieder, 2009, pp. 359, 375, 378, figures 2g, 4c, 8h, 9j, 10a, 11f, 12d, 14j, 15j, 21, table 1 (description, illustrations of pterothorax, S1–10, hamule, genital fossa, vesica spermalis, map, inclusion in key; male holotype from Explorer's Inn on Río Tambopata, Peru, in USNM).

Orthemis sp. A – Paulson (1985, p. 13, record from Tambopata, Peru).

Type specimens examined

Holotype ♂, Peru, Madre de Dios Dept., Explorer's Inn on Río Tambopata, 30 km SW Puerto Maldonado, muddy forest stream (12°30' S, 69°12' W), 17 June 1977, leg. DRP [USNM].

Other specimens examined

Total 1 ♂: Brazil, Rondônia State, Abuná (9°42' S, 65°23' W), 21 March 1922, leg. J.H. Williamson & J.W. Strohm [UMMZ].

Description of female (by supposition)

Total 1 ♀. – 1 ♀ Peru, Loreto, Aguas Negras (0°31'22" S, 75°15'24" W), 18 March 1994, leg. J. Louton [RWG].

Head. Labium black, with palps pale yellow with medial black stripe as wide as 0.33 of palp width and anterior margin narrowly black; labrum black with pair of yellow laterobasal spots; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, remainder of clypeus pale brown; ventral half of antefrons pale brown medially and yellow laterally, dorsal portion of antefrons, postfrons, and vertex dark reddish brown, with medial furrow of postfrons and vertex around ocelli with metallic blue reflections; occipital triangle reddish brown with posterior surface yellow, rear of head reddish brown with two yellow spots behind eyes. Postfrons with wide shallow medial furrow; vertex with a pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown except anterior lobe, mediodorsal area of middle lobe, and posterior margin of posterior lobe yellow. Pterothorax (Figure 2s) dark reddish brown with pale yellow stripes as follows: mesepisternum with medial longitudinal stripe adjacent to mediodorsal carina, longitudinal stripe parallel to mesepisternal–mesepimeral carina, and two spots at mid-length and at distal fourth of mesepisternal–mesepimeral carina; mesepimeron with wide stripe along posterior half narrowing dorsally; metepisternum with narrow stripe along ventral margin and another sinuous one ventral to metastigma; metepimeron with stripe along posterior half, narrowing dorsally, and oval spot on anterodorsal corner; venter of pterothorax pale yellow with lateral margins from base of leg to posterior margin dark reddish brown. – Posterior surface of

coxa, trochanter, and femur of front and middle leg and posterior surface of coxa of hind leg pale yellow, remainder dark reddish brown; tibia, tarsus, pretarsus, and spination black; metafemur armed with 15–17 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings hyaline, amber from base to level of second row of anal cells in FW and to first Anx in HW and at apex across distal three rows to distal end of pt. One cubito-anal crossvein and arculus between to Anx 2 and Anx 3, closer to Anx 2 in Fw, midway in Hw; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4–5 cells; one bridge crossvein; Fw discoidal field with 3 rows of cells at base to 5–6 rows at hind margin, Hw with 2–3 at base, then 2, then increasing to 15 at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 23–24 cells. Pt reddish brown, overlying 4–6 cells. Anx: 19–20 in Fw, 14–15 in Hw; Pnx: 14–16 in Fw, 15–17 in Hw.

Abdomen. Base swollen, narrowing abruptly from S3 to S4 (Figure 7l), S4 ca. three times as long as wide (ratio apical width/length = 0.34). Dorsal terga with mid-dorsal carina bordered by yellow on S1–7; S1–3 reddish brown with ventral third yellow; S4 reddish brown anteriorly to black posterodorsally, with orange stripe along ventrolateral carina; S5–7 black with orange stripe along ventrolateral carina; S8 black with ventrolateral flap yellow; S9–10 and caudal appendages black. Ventrolateral carina on S2 vestigial, on S3–7 well developed and black. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga (Figure 8l) dark reddish brown with yellow to orange stripe along ventrolateral carinae on S1–7; S8 pale brown; S9–10 dark reddish brown. Ventrolateral flap on S8 pale yellow (Figure 17m). Vulvar lamina extending along posterior 0.20 of sternum of S8 length, with a medial longitudinal ridge extending to S8 posterior margin (Figure 18o) bordered lateroposteriorly by semicircular ribs, and an anterior bifid transverse ridge with corners projected anteriorly into triangular concave points.

Dimensions ($n = 1$). Total length 48.4; abdomen length 32.6; Fw length 37.5; Hw length 36; maximum Hw width 10.2; Fw Pt length 4.7; Hw Pt 4.5; S4 ratio apical width/length 0.34; ventrolateral flap on S8 length 3.1, width 0.9; ratio width/length 0.29; cercus length 1.4, epiproct length 0.5.

Diagnosis

Male of *O. harpago* shares apex of epiproct wide, ca. 0.50 of epiproct maximum width or wider, and bifid with *O. aciculata*, *O. anthracina*, *O. celata*, *O. cinnamomea*, and *O. coracina*. Among them, it shares outer corner of outer branch of hamule roundly angled only with *O. coracina* (Figure 11k, m; versus smoothly rounded, Figure 11a, d, f, h), but differs from it by inner branch longer than outer branch (Figure 11m; versus ca. as long as outer branch, Figure 11k). It further differs from them except for *O. cinnamomea* by abdomen narrowing abruptly at base (Figure 4l; versus narrowing more gradually, Figures 4a–b, 19a, c–d). Mature males can be separated further from those of *O. cinnamomea* by frons and vertex metallic purple with blue reflections (versus reddish brown).

Female shares a similar vulvar lamina, characterized by the presence of a medial longitudinal ridge anterior to posterior margin of sternum S8, with *O. anthracina*, *O. aciculata*, *O. cinnamomea*, *O. coracina*, *O. cultriformis*, *O. faaseni*, and *O. flavopicta*. Among them, it is most similar to *O. cinnamomea*, *O. coracina*, and *O. faaseni* by the presence of anterolateral triangular projections on the anterior ridge of vulvar lamina (Figure 18h, j, l). However, unlike in *O. faaseni* and *O. cinnamomea* these projections are concave (Figure 18o; versus convex, Figure 18h, l). It further differs from *O. faaseni* by S4 longer and narrower (S4 length of 5.8 mm and S4 apical width/length of 0.34, versus S4 length of 4.3 mm and S4 apical width/length of 0.53), and

S8 flap yellow (Figure 17m; versus reddish brown, Figures 17j, 19l), and from *O. cinnamomea* by S8 lateral flap relatively narrower, as wide as 0.29 of its length, and ca. smoothly convex (Figure 17m; versus S8 flap relatively wider, as wide as 0.31–0.34 of its length, and triangular in contour, Figure 17f). It can be distinguished from *O. coracina* by abdomen narrowing abruptly at base, with base of S4 less than half as high as base of S3 in lateral view (Figure 7i; versus narrowing gradually, with base of S4 more than half as high as base of S3 in lateral view, Figure 7h).

Remarks

I borrowed the holotype for direct comparison with the new species described in this paper, and provide here some further illustrations not included in its original description (Figures 6i, 14l). One additional specimen of *O. harpago* from Rondônia State, Brazil was found among the examined material. Shape of hamule, vesica spermalis, abdominal ventral terga contour, cerci, and epiproct fully agree with those of holotype and paratype. As indicated by its milky wing membranes and partially crushed head and abdomen, this specimen is a teneral male, much paler in color than holotype and paratype, with thorax pale brown with pale yellow stripes, and dorsal surface of frons and vertex brown with metallic purple and blue reflections. Its size is slightly larger than that of the types: total length 43; abdomen length 27.5; Fw length 33; Hw length 32.4; maximum Hw width 8.8.

I identify the female from Loreto, Peru, as belonging to *O. harpago* by supposition. Its size is larger than that of the three known males of this species, but similar sexual dimorphism in size is known for some other species (i.e. *O. anthracina*, *O. coracina*). Color pattern including narrow black areas on premental palps, blue reflections on frons and vertex, and pattern of thoracic and abdominal stripes, as well as abdominal shape, with base narrowing abruptly and ventral terga relatively long and narrow, approach those of the male of *O. harpago*. Females of *O. celata*, *O. philipi*, *O. tambopatae*, and *O. teres* are still unknown. However, in all of them the abdomen narrows gradually at base, males of *O. tambopatae*, *O. philipi*, and *O. teres* have a mostly red abdomen, which would correlate with at least some reddish or orange areas in the female abdomen (as happens in females of other species with mostly red males, i.e. *O. ambinigra*, *O. ambirufa*, *O. paulsoni*), and known distribution of *O. celata*, *O. philipi*, and *O. teres* is widely allopatric. This female could also belong to an undescribed species close to *O. harpago*, but I prefer to be conservative and treat it here as the female of *O. harpago*. Finding more specimens of *O. harpago*, especially pairs in copula, and DNA bar-coding of both males and females, will eventually confirm or reject this association.

Distribution and biology

Lazlo Börzsöny kindly shared his recent finding of a male of this species from Panguana, Río Yuyapichis, Huanuco Prov., Peru [ZSM]. All the new records considerably extend its known distribution range to encompass N to S Peru and W Brazil (Figure 22), where *O. harpago* was found along forested streams and rivers.

Orthemis levis Calvert, 1906

Figures 7m, 10o, 11n, 12o, 13o, 16p, 17n, 18p, 20

Orthemis levis Calvert, 1906, pp. 233, 238, plate IX: figures 38–39 (description, inclusion in key, illustrations of pterothorax and male genital fossa; holotype male from San Felipe in Retalhuleu, Guatemala, in USNM, # 00316670); Ris (1910: 288; inclusion in key); Garrison

& von Ellenrieder (2004, pp. 468–469, figures 1c–d; diagnosis from *O. ambirufa*, illustrations of hamule); von Ellenrieder (2009, pp. 350, 375, 378, figures 8l, 9k, 15k, 16g, 18e, 21, plate VIIId; inclusion in key, map, illustrations of hamule, S10, flap of female S8, vulvar lamina, color picture of male).

Type specimens examined

1 ♂ paratype, Guatemala, Escuintla Dept., Santa Lucía (14°17' N, 90°47' W), 2 February 1905, leg. E.B. Williamson [UMMZ]; 2 ♂ paratypes, 4 ♀ paratypes, same but San José (13°55'32" N, 90°49'28" W), 4–5 February 1905 [UMMZ].

Other specimens examined

Total 151 ♂, 28 ♀: 1 ♂, Mexico, Yucatán State, Chichén-Itzá, cenote, at night (20°42' N, 88°35' W), 9 June 1932, E.P. Creaser [UMMZ]; 1 ♂, Mexico, Jalisco State, Arroyo Zarco, Estación de Biología Chamela (19°30' N, 105°0' W), 27 November 1994, leg. E. González S., R. Mendoza & A. Godínez [RWG]; 1 ♂, same but Arroyo Chamela, 26 July 1994 [RWG]; 1 ♂, Mexico, Tabasco State, Tepescuintle, Tenosique (17°27' N, 91°24' W), 14 September 1962, leg. E.C. Welling & L.K. Gloyd [UMMZ]; 1 ♀, Belize, Toledo Dist., Silver Creek Village, southern Highway & South Stann Creek (16°16'48" N, 88°53'23" W), 9 June 1993, leg. W.F. Mauffray [FSCA]; 3 ♂, Belize, Toledo Dist., Punta Gorda (16°6'10" N, 88°50'0" W), June 1933, leg. J.J. White [UMMZ]; 1 ♂, same but [RWG]; 1 ♂, same but [FSCA]; 2 ♂, Belize, Toledo Dist., Río Temash (15°58'35" N, 88°56'31" W), April 1934, leg. J.J. White [UMMZ]; 1 ♂, same but June 1934 [UMMZ]; 1 ♂, Guatemala, El Petén Dept., Uuxactun (17°23'37" N, 89°38'1" W), 13 May 1931, leg. A. Murie [UMMZ]; 5 ♂, Guatemala, Izabal Dept., Puerto Barrios (15°43' N, 88°36' W), 26–30 May 1909, leg. E.B. Williamson [UMMZ]; 1 ♀, Guatemala, Izabal Dept., Morales (15°29' N, 88°49' W), 27 May 1909, E. B. Williamson [UMMZ]; 16 ♂, 3 ♀, Guatemala, Zacapa Dept., Gualán (15°6'56" N, 89°21'40" W), 30 May/20 June 1909, leg. E.B. Williamson [UMMZ]; 4 ♂, 1 ♀, Guatemala, Zacapa Dept., Gualán (15°6'56" N, 89°21'40" W), 14–20 June 1909, C.C. Dean [UMMZ]; 1 ♂, Guatemala, El Progreso Dept., 6.6 mi SE Morazán (14°53'57" N, 90°4'41" W), 7 September 1961, leg. Hubbell, Cantrall & Cohn [UMMZ]; 1 ♀, Honduras, Francisco Morazán Dept., Zamorano, Quebrada El Gallo, small stream (14°1' N, 87°2' W), 8 March 1990, leg. S.W. Dunkle [RWG]; 1 ♂, Honduras, Olancho Dept., Jalán River S of Juticalpa (4°35'17" S, 86°17'50" W), 18 December 1987, leg. S.W. Dunkle [RWG]; 1 ♂, 1 ♀, Costa Rica, Guanacaste Prov., Hacienda Taboga (10°20' N, 85°12' W), 6–15 July 1966, D.R. Paulson [RWG]; 1 ♂, same but 3 May 1967 [RWG]; 1 ♀, Costa Rica, Alajuela Prov., Los Chiles (10°25' N, 84°20' W), 31 August 1966, D. Paulson [DRP]; 6 ♂, Colombia, Magdalena Dept., El Banco (9°2'50" N, 73°58'41" W), 23–24 January 1917, leg. J.H. & E.B. Williamson [UMMZ]; 48 ♂, 6 ♀, Venezuela, Zulia State, El Guayabo (10°37'20" N, 71°51'12" W), 20 April 1920, J.H. & E.B. Williamson & W.H. Ditzler [UMMZ]; 4 ♂, same but [RWG]; 4 ♂, 1 ♀, Venezuela, Zulia State, Encontrados (9°3'51" N, 72°13'55" W), 25 April 1920, J.H. & E.B. Williamson & W.H. Ditzler [UMMZ]; 1 ♂, Venezuela, Vargas State, Macuto (10°37' N, 66°53' W), 29 January 1920, J.H. & E.B. Williamson & W.H. Ditzler [UMMZ]; 20 ♂, 3 ♀, Venezuela, Falcón State, Palma Sola (10°36'14" N, 68°32'44" W), 4–10 March 1920, J.H. & E.B. Williamson & W.H. Ditzler [UMMZ]; 4 ♂, 2 ♀, Venezuela, Yaracuy State, Boquerón (10°34'17" N, 68°49'13" W), 18–19 March 1920, leg. J.H. & E.B. Williamson & W.H. Ditzler [UMMZ]; 2 ♂, Venezuela, Carabobo State, San Esteban (10°25'58" N, 68°4'40" W), 6 February 1920, leg. J.H. & E.B. Williamson & W.H. Ditzler [UMMZ]; 1 ♂, 1 ♀, same but 3 February 1920 [RWG]; 1 ♀, Venezuela, Sucre State, Santa Fe (10°16' N, 64°25' W), 5 April 1955, leg. J. Rácenis [RWG]; 1 ♀, Venezuela, Barinas State, San Silvestre (8°16'47" N, 70°6'30" W), 20–21 December 1957,

leg J. Rácenis [FSCA]; 2 ♂, Venezuela, Táchira State, La Fría (8°13'7" N, 72°14'55" W), 15–17 April 1920, leg. J.H. & E.B. Williamson & W.H. Ditzler [UMMZ].

Diagnosis

Male of *O. levis* has metallic purple frons and vertex, labial palp with medial black stripe as wide as 0.33–0.40 of palp width, pterothorax reddish brown with yellow stripes, which can be obscured in mature males, dorsal terga S1–7 mostly red, with ventrolateral and posterior carinae narrowly black, and S8–10 dorsally black. Abdomen narrows abruptly from S2 to S4, and S4 is about as wide at level of apical carina as 0.27–0.37 of its length. Hamule inner and outer branches are located in the same plane, with both ending at about the same level (Figure 10o); inner corner of outer branch is smoothly rounded (Figure 11n). Distal segment of vesica spermalis is ca. oval, with sides gradually converging to distal end in ectal view (Figure 13o), paired distal short medial longitudinal membranous lobes beset with denticles along distal margin on ectal side, paired outer lateral lobes shorter than basal sclerotized portion of distal segment folded medially to the sides, and paired flagella (Figure 12o). Cercus curves ventrally gradually and its tip is slightly upturned. Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16p). Male of *O. levis* shares combination of abruptly narrowed abdomen at base and epiproct tip narrow and entire only with *O. attenuata* and *O. concolor*. It differs from both by its red abdominal color pattern, with only S8–10 dorsally black (versus S4–7 or S5–7 mostly black with narrow medial longitudinal and ventrolateral yellow to orange stripes), and by shape of abdomen base between apex of S2 and base of S3, which is less globose in *O. levis* (versus more globose, Figures 4d, 19e–f, i–j). It further differs from *O. concolor* by metallic purple frons and vertex and pterothorax with yellow stripes, versus frons and vertex reddish brown and pterothorax concolorous reddish brown (Figure 19g).

Female shares with male: labial palp with narrow medial black stripe (0.25–0.40 of palp width), pterothorax reddish brown with yellow stripes, and slender abdomen narrowing abruptly from S2 to S4 (Figure 7m). Color of dorsal abdominal terga is similar to that of male. Ventrolateral flap on S8 (Figure 17n) is yellow and relatively narrow, ca. 0.22–0.28 as wide as its length, with a smoothly curved contour. Sternum S8 is smooth, with vulvar lamina consisting of posterior margin of sternum of S8 forming a shallow inverted U-shaped rim, with medial excision narrower than its lateral margins (Figure 18p). Combination of relatively slender abdomen narrowing abruptly at base, with base of S4 less than half as high as base of S3 in lateral view, and vulvar lamina consisting of shallow U-shaped rim of S8 posterior margin is shared only with *O. attenuata* and *O. concolor*. *Orthemis levis* differs from both by red color present on abdominal dorsal terga S4–7 and by shape of the abdomen base between the apex of S2 and the base of S3, which is less globose in *O. levis* (Figure 7m; versus more globose, Figure 7e, g). It further differs from *O. concolor* by pterothorax with yellow stripes and by paired depressions anterior to vulvar lamina rim located directly anterior to lateral margins of rim (Figure 18p; versus located laterally and outwards from lateral margins of rim in *O. concolor*, Figure 18i). Since red color on abdominal dorsal terga S4–7 is not as pronounced as it is in the males, being sometimes replaced by reddish brown on S1–4 to S1–7, and since unlike in males, there are yellow to orange paler stripes along mediodorsal and ventrolateral carinae of S1–7 to S1–8, poorly preserved females especially can look very similar in abdominal color to those of *O. attenuata* and *O. concolor*.

Remarks

Among the examined material, specimens from South America seem to have in general a more slender abdomen than those of North America, but there are intermediates in Central America,

and I was unable to find any morphological differences justifying the recognition of two species or subspecies, and treat this variability as geographical variation.

Distribution and biology

Orthemis levis is a widespread species from Mexico in North America south to N Colombia and Venezuela in South America (Figure 20). It is found near streams and rivers in forested areas.

Orthemis paulsoni sp. nov.

Figures 1j, 3a, 2t–u, 4j, 6j, 7n, 8m, 10p, 11q, 12p, 13p, 14m, 15s–t, 16q, 17 o, 18r, 19p, 21

Orthemis plaumanni nec Buchholz, 1950 – von Ellenrieder (2009, pp. 350, 375, 380, figures 8n, 9m, 14l, 15m, 16h, 17c, 18f, 19, table 1; illustrations of hamule, S10, female S8 flap, and vulvar lamina, map, inclusion in key; misidentification).

Etymology

This species is named *paulsoni* (noun in the genitive case) after Dennis R. Paulson, who lent me the first specimens I examined, in recognition of his always available kind advice and encouragement to me and to other numerous odonate students and of his invaluable contributions to the knowledge of New World odonate diversity.

Type specimens

Total 4 ♂ 2 ♀. – Holotype ♂: Ecuador, Sucumbíos Prov., forest trail ca. 3 km W of Shushufindi (00°09'59" N, 76°41'30" W), 14 October 2009, leg. K.J. Tennessen [FSCA]; paratypes: 1 ♂, same as holotype [KJT]; 1 ♂, same as holotype but 14 May 2009 [JJD]; 1 ♀, Ecuador, Orellana Prov., Tiputini Biodiversity Station USFQ, open grassy area behind dining room, surrounded by bushes and trees and some seepage areas (00°38'18" S, 76°08'57" W), 11 January 2009, leg. RWG & NE [RWG]; 1 ♂, Peru, Madre de Dios Dept., Tambopata Nature Reserve, 30 km S of Puerto Maldonado, 450 m on main trail, 11:17 h (12°30' S, 69°12' W), 22 December 1986, leg. P.K. Donahue [DRP]; 1 ♀, same but 100 m on main trail, ovipositing in puddles at 11:27 h, 20 December 1986 [DRP].

Male holotype

Head. Labium black, with palps pale yellow with medial black stripe as wide as ca. 0.40 of palp width and anterior margin narrowly black (Figure 1j); labrum black with mediobasal reddish spot; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, remainder of anteclypeus pale brown, postclypeus pale brown with medial dark brown spot and postclypeal lobes narrowly fringed with dark brown line along distal margin; ventral half of antefrons pale brown medially and pale yellow laterally, dorsal portion of antefrons, postfrons, and vertex metallic blue with purple reflections, occipital dark reddish brown, rear of head reddish brown with two pale yellow spots behind eye. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown except anterior lobe margined with pale yellow. Dorsum and sides of pterothorax (Figure 2t) entirely covered with bluish white pruinescence, some exposed areas dark reddish brown, with pale yellow stripe along posterior half of metepimeron partly

evident; venter of pterothorax reddish brown. – Legs with coxa, trochanter, and inner surface of femur pale reddish brown; remainder of femur reddish brown basally to dark reddish brown distally; tibia dark reddish brown; tarsus, pretarsus, and spines black; metafemur armed with 10 (right) to 11 (left) short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings (as in Figure 3a) slightly infumated. One cubito-anal crossvein and arculus opposite to Anx 2 in Fw and Hw; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 cells; two bridge crossveins in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 5 rows at hind margin, Hw with 2 rows of cells at base, increasing to 14 (right) or 15 (left) at hind margin; 4 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 20 (right) cells (incomplete on left wing). Pt reddish brown, 4.7 long in Fw and 4.5 in Hw, overlying 5 cells in Fw and 4 cells in Hw. Anx: 16 (right) to 17 (left) in Fw; 12 (right) to 13 (left) in Hw; Pnx: 15 in Fw and Hw.

Abdomen. Gradually narrowing from base to apex in ventral view (Figure 4j), S4 slightly longer than wide (ratio apical width/length = 0.85). Dorsal terga: S1 and basal half of S2 pale reddish brown; distal half of S2 and S3 dark red; S4–9 bright red with mid-dorsal, ventrolateral, and posterior carinae margined in black, and with small diffuse laterodistal black spot; S10 dark reddish brown with mediodorsal dark red spot; caudal appendages dark reddish brown. Ventrolateral carina on S2 vestigial, on S3–8 well developed, on S9 well developed along basal two thirds, absent at distal third. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga reddish brown, with orange pale lateral longitudinal stripes along outer two-thirds of S2–8 (Figure 6j). Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Figure 10p); hamule bifid with small inner branch forming short pointed spine, in same plane as rounded outer branch, separated by distance shorter than inner branch length (Figure 11q). Distal segment of vesica spermalis with basal portion approximately rectangular in ectal view, widest at apex, with sides concave near apex, and with long flagella on ental surface (Figure 13p); distal portion represented on each side by ental lobe, with sclerotized subtriangular portion shorter than basal portion of distal segment in lateral view, folded medially into transverse membranous portion, approximately oval in ectal view, about as long as half of basal portion, and medioectal membranous lobe with lateral longitudinal sclerotized ridge covered with denticles; medioectal lobe almost as long as outer lobe (Figure 12p). Cercus slightly curved ventrally in lateral view, with row of 7 (left) to 8 (right) ventral tubercles along venter of dilated portion and tip slightly upturned (Figure 15s); in dorsal view converging along basal 0.70 with opposite cercus, then approximately parallel to it along distal 0.30 (Figure 14m). Epiproct extending to 0.82 of cercus length, with apex slightly concave and as wide as 0.4 of its basal width (as in Figure 16q).

Dimensions. Total length 46.8; abdomen length 29; Fw length 37.6; Hw length 36.4; Hw maximum width 10.8; cercus length 2; epiproct length 1.65; epiproct maximum width 1; epiproct subapical width 0.4.

Variation in male paratypes

Head. As for holotype but labial palp medial black stripe as wide as about 0.33 of palp width in one paratype.

Thorax. As for holotype but 14–17 + 1 metafemoral spurs; in three paratypes arculus between Anx 2 and 3, closer to Anx 2 or midway; Fw subtriangle with 3 cells in one wing; Fw discoidal field with 5–6 rows of cells at hind margin, Hw with 2–3 then 2 then 14–18 at hind margin; anal

loop enclosing 19–22 cells. Pt overlying 4–6 cells in Fw, 4–5 in Hw; Anx 14–18 in Fw, 12–15 in Hw; Pnx 14–16 in Fw, 15–18 in Hw.

Abdomen. As for holotype but ratio S4 width/length: 0.59–0.74; caudal appendages covered in bluish white pruinescence in one paratype; 5–7 ventral tubercles on cercus.

Dimensions ($n = 3$). Male total length 41.8–46.7; abdomen length 25–28.7; Fw length 35.8–37.4; Hw length 34.9–35.9; maximum Hw width 10–10.6; Fw Pt length 4.3–4.4; Hw Pt length 4.3–4.4; cercus length 1.9–1.95; epiproct length 1.5–1.65; epiproct maximum width 1–1.05; epiproct subapical width 0.4.

Average dimensions ($n = 4$). Male total length 45.37 ± 2.39 ; abdomen length 27.77 ± 1.86 ; Fw length 36.95 ± 0.8 ; Hw length 35.7 ± 0.62 ; maximum Hw width 10.4 ± 0.36 ; cercus length 1.95 ± 0.04 ; epiproct length 1.61 ± 0.07 ; epiproct maximum width 1.01 ± 0.02 ; epiproct subapical width 0.4 ± 0 .

Variation in female paratypes

Head. As for holotype but medial black stripe as wide as ca. 0.33–0.40 of palp width labrum with basal pale yellow spot on medial half; antefrons medially and postfrons, vertex, and occipital triangle reddish brown, with dark blue metallic reflections along postfrons medial furrow and surrounding the ocelli on vertex.

Thorax. As for holotype but pruinescence extending onto venter of pterothorax, and thin on dorsum and sides, making pale diffuse yellowish stripes visible: narrow stripe along mid-dorsal carina, and wide stripes along mid width of mesepimeron, posterior edge of mesepimeron, and posterior edge of metepimeron (Figure 2u). Metafemur armed with 10–13 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Arculus between Anx 2–3, closer to Anx 2; one paratype with 1 bridge crossvein on left wings, one paratype with 1 bridge crossvein on right wings and left Hw; Fw discoidal field with 4–7 cells at hind margin, Hw with 14–19; anal loop enclosing 19–23 cells. Pt overlying 5–6 cells in Fw and 4–7 cells in Hw. Anx: 15–18 in Fw, 12–14 in Hw; Pnx: 13–15 in Fw, 15–16 in Hw.

Abdomen. As for holotype but ratio S4 apical width/length = 0.89–1.0 (Figure 8m). Ventrolateral carina on S4–5 present, on S9 absent. Distal black spot on dorsum of S8 extended to posterior margin, on S9 forming a complete anteroposterior black stripe (Figure 7n); S10 dark reddish brown. Ventrolateral flap on S8 yellow narrowly margined in black (Figure 17o). Vulvar lamina consisting of posterior margin of S8 forming a rim with a deep medial inverted U-shaped excision and paired depressions under convex lateral margins (Figure 18r).

Dimensions ($n = 2$). Total length 43.75–44; abdomen length 27.5–27.8; Fw length 38–38.4; Hw length 36.8–38; maximum Hw width 10–10.2; Fw Pt length 5.3; Hw Pt length 5–5.1; ventrolateral flap on S8 length 3.05–3.15, width 0.9; ratio width/length 0.28–0.29; cercus length 1.2–1.3; epiproct length 0.55–0.85; epiproct maximum width 0.75–0.8.

Diagnosis

Orthemis paulsoni can be diagnosed from all species in the *levis* group by its relatively wider abdomen (Figures 6j, 8m, 19p), with S4 apical width/length ratio of 0.59–0.85 in males and 0.89–1.0 in females; versus abdomen more slender, with S4 apical width/length ratio of 0.19–0.56 in males and 0.3–0.57 in females (Figures 6a–i, k–l, 8a–l). Male shares combination of a mostly red abdomen gradually narrowing at base, epiproct narrow at apex, and hamule with inner and outer branches in about the same plane only with *O. ambinigra*, *O. ambirufa*, *O. tambopatae*, and *O. teres* among species in the *levis* group. It further differs from *O. ambirufa* by frons and vertex metallic purple with blue reflections (versus reddish brown lacking metallic reflections), and cercus markedly curved ventrally (Figures 15s–t; versus almost straight and curved ventrally only slightly, Figure 15d), and from the other three species by inner corner of outer branch of hamule smoothly rounded (Figure 11q; versus roundly angled or pointed, Figure 11b, t–u).

Female shares vulvar lamina consisting of posterior margin forming an inverted U-shaped rim only with *O. ambirufa*, *O. attenuata*, *O. concolor*, and *O. levis* within the *levis* group; versus vulvar lamina consisting of transverse and/or longitudinal rims anterior to posterior margin of S8. Among them, it differs from *O. ambirufa* by medial excision of vulvar lamina narrower than its lateral margins (Figure 18r; versus wider than its lateral margins, Figure 18d), and from the other three species by abdomen wide and only slightly and gradually narrowed at base (Figures 7n, 8m; versus abdomen slender, abruptly narrowed at base, Figures 7e, g, m, 8e, g).

Within the *ferruginea* group, male of *O. paulsoni* is unique by its cerci markedly curved ventrally (Figure 15s–t). In other known species of this group cerci curve ventrally only slightly (i.e. Figure 15g). *Orthemis paulsoni* resembles *O. biolleyi* by combination of bright red abdomen and outer corner of male hamule not triangular and projected posteriorly (Figure 11g, q), but it can easily be distinguished from it by male postfrons and vertex metallic blue versus metallic purple in *O. biolleyi*, and pterothorax pruinulent blue in mature males and bearing four pale yellowish stripes in females (probably also in teneral males), versus with six bright yellow stripes in males and females of *O. biolleyi*. Female of *O. paulsoni* can be diagnosed from all species in the *ferruginea* group by rim of vulvar lamina with a deep inverted U-shaped medial excision and paired depressions under the convex lateral margins (Figure 18r), versus rim of vulvar lamina lacking a deep medial inverted U-shaped excision, either ca. straight, shallowly concave, or slightly bilobate (Figure 18f, q, t).

Remarks

I mistakenly treated and illustrated this species as *O. plaumanni* in my previous analysis of the *levis* group of *Orthemis* (von Ellenrieder, 2009). Buchholz (1950) diagnosed *O. plaumanni* from other species in this group solely on the basis of presence of two bridge crossveins in the wings, and all the wings of the examined males and some wings of the examined females of *O. paulsoni* have two bridge crossveins. Even though the two specimens of *O. paulsoni* from Peru available to me earlier seemed to fit the description of *O. plaumanni* well, the shape of the hamule differed from that illustrated by Buchholz (1950) for that species. In order to confirm the identification I borrowed the holotype of *O. plaumanni* from ZFMK, and its examination revealed that *O. plaumanni* is a junior synonym of *O. ambinigra*, and that *O. paulsoni* is in fact a new species.

Additional specimens of *O. paulsoni* from Ecuador examined here showed that the abdomen in this species is wider than in all species of the *levis* group, pointing to the correct placement of this species in the *ferruginea* group rather than in the *levis* group. This is also indicated by the presence of four rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (Figure 3a) in most wings (in two of the males and one female one of the Hw has three rows

and only isolated cells in a fourth position), characteristic of all *ferruginea* group species and of *O. regalis*.

Distribution and biology

Known from SE Peru and Ecuador (Figure 21), where it was found along forested trails, and female was observed ovipositing in associated puddles.

Orthemis philipi von Ellenrieder, 2009

Figures 1k–l, 2v, 3b, 4k, 6k, 9h, 10q, 11r, 12q, 13r, 14n, 15r, 16r, 22

Orthemis philipi von Ellenrieder, 2009, pp. 362, 375, 379, figures 1b–c, 2h, 3a–b, 4d–e, 8m, 9l, 10b, 11g, 12e, 13c, 14k, 15l, 19, plate VIIe, f, table 1 (description, illustrations of labium, pterothorax, wings, hind femur, S1–10, hamule, genital fossa, vesica spermalis, map, inclusion in key, color pictures of male).

Specimens examined

Total 5 ♂: 1 ♂ paratype, Argentina, Salta Prov., pond at route 15 between route 5 and Las Varas (23°21'19" S, 64°08'37" W, 392 m), 23 May 2008, leg. NE [NE]; 1 ♂ paratype, same but [RWG]; 2 ♂, Paraguay, Boquerón Dept., 29 km S of Fortín Madrejón to Filadelfia (20°39'46" S, 59°51'27" W, 130 m), 20 September 1994, leg. B. Cousino [FSCA]; 1 ♂, Paraguay, Presidente Hayes Dept., Estancia La Golondrina (24°38'00" S, 55°21'00" W, 277 m), 19 June 1985, leg. T. Bonace [FSCA].

Diagnosis

Male of *O. philipi* has metallic blue frons and vertex, labial palp with medial black stripe as wide as 0.20–0.33 of palp width (Figures 1k–l), pterothorax “marbled” reddish brown with pale yellow spots (Figure 2v), and dorsal terga S4–9 red to orange (Figure 4k). Abdomen narrows gradually from S2 to S4 (Figures 4k, 6k), and S4 is about as wide at level of apical carina as 0.47–0.49 of its length. Hamule inner and outer branches are located in the same plane (Figure 9h), with outer branch bent ventrally over inner branch (Figure 10q); inner corner of outer branch is pointed and outer corner is rounded (Figure 11r). Basal portion of distal segment of vesica spermalis is parallel sided in ectal view (Figure 13r), and distal portion has paired short medial longitudinal membranous lobes beset with denticles on their margins; paired outer lateral lobes are folded medially to the sides and are shorter than basal sclerotized portion of distal segment (Figure 12q). Cercus (Figure 14n) curves ventrally gradually (Figure 15r) and its tip is slightly upturned. Epiproct apex is about as wide as a third or less of its maximum width (Figure 16r).

Male of *O. philipi* shares combination of hamule with outer branch bent ventrally over inner branch and epiproct apex relatively narrow, subapically less than 0.45 of its maximum width, only with *O. cultriformis*, *O. tambopatae*, and *O. teres*. It differs from all by its marbled pterothorax (Figure 2v; versus pterothorax dark reddish brown to black with yellow stripes or entirely dark in mature males, Figure 2k, w–x). It further differs from *O. cultriformis* by inner and outer branches of hamule separated by a distance shorter than length of inner branch, and vesica spermalis distal segment parallel sided in ectal view (Figures 11r, 13r; versus inner and outer branches of hamule separated by a distance longer than length of inner branch, and vesica spermalis distal segment rhomboidal in ectal view, Figures 11j, 13j), and from *O. tambopatae* and *O. teres* by ventral surface of outer branch of hamule smooth (Figure 11r; versus grooved, Figure 11t–u).

Female unknown.

Distribution and biology

Orthemis philipi is known from the dry Chaco forest in Paraguay and N Argentina (Figure 22), where it was found at muddy temporary ponds.

Orthemis regalis Ris, 1910

Figures 7o, 10r, 11s, 12r, 13q, 15u, 16s, 17p, 18s, 21

Orthemis regalis Ris, 1910, pp. 279, 281, figures 159–161 (inclusion in key, description, illustrations of wings, genital fossa, and female S8–10); von Ellenrieder (2009, pp. 350, 375, 378, 3, 9n, 19, plate VIIg, table 1; inclusion in key, illustrations of wings and hamule, map, color picture of male).

Specimens examined

Total 2 ♂, 1 ♀: 1 ♂, Surinam, Tapanahoni River, Granholosoela (4°7'48" N, 54°37'48" W), 4 April 1963, leg. J. Belle [RWG]; 1 ♂, Surinam, Brokopondo Distr., Brownsveg (5°1' N, 55°10' W), 30 January 1972, leg. D.C. Geijskes [RMNH]; 1 ♂, Brazil, Pará State, Carajás (2°57' S, 51°52' W), February 1994, A. & S. Lapertosa & A.B.M. Machado [RWG].

Diagnosis

Male of *O. regalis* has dark metallic purple frons and vertex, labial palp with medial black stripe as wide as 0.30–0.33 of palp width, pterothorax dark brown to purple with metallic reflections and well-defined yellow stripes, and dorsal terga S1–7 dark reddish brown to black, with yellow stripes along medial longitudinal and ventrolateral carinae, S8 black with yellow stripes along ventrolateral carina, and S9–10 black. Abdomen narrows gradually from S2 to S4, and S4 is about as wide at level of apical carina as 0.48–0.52 of its length. Hamule inner and outer branches are located in the same plane, ending at ca. the same level, with inner corner of outer branch rounded and outer corner triangular and projected ventroposteriorly (Figures 10r, 11s). Basal portion of distal segment of vesica spermalis is medially constricted in ectal view (Figure 13q), distal portion has paired distal short medial longitudinal membranous lobes, and paired outer lateral lobes which are folded medially to the sides and are shorter than basal sclerotized portion of distal segment (Figure 12r). Cercus curves ventrally only slightly (Figure 15u) and its tip is slightly upturned. Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16s).

Female shares color pattern with male, except for frons and vertex dark reddish brown with metallic blue reflections. Abdomen narrows gradually from S2 to S4 (Figure 7o), and S4 is about as wide at level of apical carina as ca. 0.54 of its length. Ventrolateral flap on S8 is black and narrow, as wide as ca. 0.1 of its length (Figure 17p). Vulvar lamina is represented by bilobate posterior margin of S8 (Figure 18s).

Both male and female of *O. regalis* are unique within the genus by wings with extensive dark markings along C-RA space (versus dark markings restricted to base [i.e. *O. philipi*] or base and nodus [i.e. *O. nodiplaga*], if present at all) and male further by basal sclerotized portion of vesica spermalis deeply constricted medially in ectal view (Figure 13q; versus basal portion with sides convex to concave or slightly constricted in ectal view, never deeply constricted, i.e. Figure 13a–o, r–s). Within the *levis* group, *O. regalis* shares combination of a dark reddish brown to black abdomen with narrow medial longitudinal and ventrolateral yellow stripes on S4–7, gradually narrowing at base, male epiproct narrow at apex, and hamule with inner and outer branches in about the same plane only with *O. flavopicta* and *O. garrisoni*. It differs from them and from all other *levis* group species by its larger size (Hw > 50 mm), presence of four rows of cells between

anal margin of hind wing and AA2 at level of heel of anal loop (as in Figure 3a), outer corner of outer branch of hamule triangular and projected ventroposteriorly in lateral view (Figure 10r), and female S8 ventrolateral flap extremely narrow (as wide as 0.1 of its length, Figure 17p); versus smaller size (Hw < 45 mm), presence of two or three rows of cells between anal margin of hind wing and AA2 at level of heel of anal loop (Figure 3b), outer corner of outer branch of hamule not triangular and projected ventroposteriorly in lateral view (Figure 10a–q, s–t), and female S8 ventrolateral flap relatively wider (as wide as 0.20–0.37 of its length, Figures 17a–o). It can be diagnosed from all species in the *ferruginea* group by its relatively more slender abdomen, with S4 width/length male ratio of 0.48–0.52 and female ratio of 0.54 (versus male and female ratio of 0.59 or more).

Remarks

As this species is so easily recognizable based on its unique wing color pattern and large size, study of other diagnostic characters has been neglected in the literature; in order to partially compensate for this I provide a brief characterization and diagnosis, including illustrations of vesica spermalis (Figures 12r, 13q), caudal appendages (Figures 15u, 16s), female S8 ventrolateral flap (Figure 17p), and vulvar lamina (Figure 18s).

Distribution and biology

Orthemis regalis occurs in the Amazon forest of N South America, extending from Venezuela and Surinam to Ecuador N Peru and N Brazil (Figure 21), being found along deep forest rivers and trails.

Orthemis tambopatae von Ellenrieder, 2009

Figures 2w, 4l, 10s, 11t, 12s, 13s, 15v, 16t, 22

Orthemis tambopatae von Ellenrieder, 2009, pp. 368, 375, 380, figures 2i, 4f, 8o, 9o, 11h, 12f, 14m, 15n, 20, plate VIIIh, table 1 (description, illustrations of pterothorax, S1–10, hamule, genital fossa, vesica spermalis, map, inclusion in key, color photo of male; holotype male from Explorer's Inn on Río Tambopata, Peru, in USNM).

Orthemis sp. B – Paulson (1985, p. 13, record from Tambopata, Peru).

Orthemis sp. (nearest *ambinigra*) – Butt (1995, p. 96, record from Tambopata, Peru).

Type specimens examined

2 ♂ paratypes, Peru, Madre de Dios Dept., Tambopata-Cándamo Reserved Zone, Camp 3, the Collpa, Río Tambopata west bank, marsh (13°8'31" S, 69°36'4" W), 1 September 1992, leg. M. Butt [RWG].

Other specimens examined

Total 2 ♂: 1 ♂, Bolivia, Santa Cruz Dept., pond nr. Río San Julián, 4 km S of San Ramón (16°38'42" S, 62°30'31" W), 12 August 2003, leg. K.J. Tennessen [KJT]; 1 ♂, Bolivia, Santa Cruz Dept., Quebrada Curichi, 3.5 km S of Buena Vista (17°27'0" S, 63°40'6" W), 7 February 2001, leg. Jerrell J. Daigle [FSCA].

Diagnosis

Male of *O. tambopatae* has metallic purple frons and vertex, labial palp with medial black stripe as wide as 0.33–0.60 of palp width, pterothorax reddish brown with yellow stripes (Figure 2w), and dorsal terga S3–8 mostly red. Abdomen narrows gradually from S2 to S4 (Figure 4l), and S4 is about as wide at level of apical carina as 0.38–0.47 of its length. Hamule inner and outer branches form an acute angle between them, with outer branch bent ventrally over inner branch, inner corner of outer branch pointed, and outer surface of outer branch grooved (Figure 11t). Basal portion of distal segment of vesica spermalis is ca. rectangular and only slightly widening distally with sides slightly concave in ectal view (Figure 13t), distal portion has a membranous outer ental lobe ca. as long as basal sclerotized portion in lateral view (Figure 12t), and medioectal sclerotized lobe is ca. half as long as outer membranous lobe in ectal view (Figure 13t). Cercus curves ventrally abruptly (Figure 15v) and its tip is strongly upturned. Epiproct apex is about as wide as a third or less of its maximum width, and is not bifid (Figure 16t). Male of *O. tambopatae* shares combination of hamule with outer branch bent ventrally over inner branch and epiproct apex relatively narrow, subapically less than 0.45 of its basal width (Figure 16t), only with *O. cultriformis*, *O. philipi*, and *O. teres*. It differs from *O. cultriformis* and *O. philipi* by the grooved ventral surface of outer branch of hamule (Figure 11t, versus smooth, Figure 11j, r), and further from *O. cultriformis* by vesica spermalis basal portion of distal segment ca. rectangular in ectal view (Figure 13t; versus ca. rhomboidal, Figure 13j), and from *O. philipi* by pterothorax reddish brown with yellow stripes (Figure 2w; versus pterothorax marbled, Figure 2v). It can be distinguished from *O. teres* by hamule inner and outer branches forming an acute angle between them (Figure 11t; versus forming a rounded open curve, Figure 11u), and by distal segment of vesica spermalis with basal sclerotized portion much longer than its maximum width (Figure 13t; versus as long as its maximum width, Figure 13t) and distal outer membranous lobe ca. twice as long as distal medioectal membranous lobe and ca. as long as basal sclerotized portion (Figure 12t; versus distal outer membranous lobe ca. as long as distal medioectal membranous lobe and distinctly shorter than basal sclerotized portion, Figure 12t).

Female unknown.

Distribution and biology

Orthemis tambopatae is so far known from S Peru and Bolivia (Figure 22), associated with marshy areas along rivers, oxbow ponds, and temporary pools in forested areas.

Orthemis teres sp. nov.

Figures 2x, 4m, 6l, 9i, 10t, 11u, 12t, 13t, 14o, 15w, 16u, 22

Etymology

From Latin *teres* (rounded off), an adjective referring to the rounded contour of hamule branches and vesica spermalis distal segment.

Type specimens

Total 1 ♂. – Holotype ♂: Bolivia, Cochabamba Dept., Chapare, Cristal Mayo (17°0'57" N, 65°38'09" W), October–November 1994, leg. R. Andreas [FSCA].

Male holotype

Head. Labium black, palps missing; labrum black with small mediobasal reddish spot; base of mandibles brown; lateral portion of clypeus along eyes pale brown, remainder of anteclypeus brown, postclypeus brown with postclypeal lobes fringed with black line along distal margin; ventral half of antefrons brown, dorsal portion of antefrons, postfrons, and vertex metallic purple, occipital triangle dark reddish brown with black margins, rear of head reddish brown. Postfrons with wide shallow medial furrow; vertex with pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax. Prothorax reddish brown. Pterothorax (Figure 2x) dark reddish brown, with paler reddish to yellow diffuse stripes as follows: mesepisternum with narrow medial longitudinal stripe adjacent to mediodorsal carina and longitudinal stripe parallel to mesepisternal–mesepimeral carina; narrow stripe along mesepisternal–mesepimeral carina; wide stripe along posterior half of mesepimeron narrowing dorsally; narrow stripe along ventral margin of metepisternum and another sinuous one ventral to metastigma; metepimeron with stripe along anterior half and another along posterior half; venter of pterothorax dark brown with pale reddish medial longitudinal stripe along basal half, bifurcated into two diverging stripes on distal half. – Legs with coxa and trochanter pale brown; femur and tibia dark reddish brown; tarsus, pretarsus, and spines black; metafemur armed with 20 short spurs which slightly and gradually increase in size towards apex, followed distally by one longer spur. – Wings hyaline with small amber spot at base. One cubito-anal crossvein and arculus between Anx 2 and Anx 3 but closer to Anx 2; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 cells; two bridge crossveins in Fw and Hw on right, 1 on left; Fw discoidal field with 3 rows of cells at base to 5 (right) or 7 (left) rows at hind margin, Hw with 3 rows of cells at base, then 2, then increasing to 15 (right) or 13 (left) at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 23 (right) or 25 (left) cells. Pt reddish brown, 4.7 long in Fw and 4.5 in Hw, overlying 4–5 cells in Fw and 4 cells in Hw. Anx: 15 (right) to 17 (left) in Fw; 13 in Hw; Pnx: 13 in Fw, and 15 (right) or 14 (left) in Hw.

Abdomen. Gradually narrowing from base to apex in ventral view (Figure 6l), S4 slightly longer than wide (ratio apical width/length = 0.89). Dorsal terga (Figure 4m): pale reddish orange, with ventrolateral and posterior carinae on S3–10 margined in black, and with small diffuse laterodistal black spot; S10 black at anterior margin, with black extended posteriorly to mid-length of segment at center; caudal appendages dark reddish brown. Ventrolateral carina on S2 vestigial, on S3–8 well developed, on S9 well developed along basal two thirds, absent at distal third. Transverse carina well developed on S2–3, vestigial on S4–5. Ventral terga reddish brown, with paler orange lateral longitudinal stripes along outer two-thirds of S3–9 (Figure 6l). Anterior lamina in lateral view shorter than hamule and genital lobe (Figure 10t); hamule bifid with small inner branch forming short pointed spine, appressed against rounded outer branch (Figure 9i), not visible in lateral or frontal views; outer branch with deep groove on its outer surface (Figures 10t, 11u). Distal segment of vesica spermalis with basal portion trapezoidal in ectal view, widest near distal end, with sides approximately straight, and with long flagella on ental surface (Figure 13t); distal portion represented on each side by membranous outer ental lobe, with sclerotized subtriangular portion shorter than basal portion of distal segment in lateral view, folded medially into transverse membranous portion, approximately rectangular in ectal view, ca. as long as half of basal portion, and medioectal sclerotized lobe with minute denticles along margin; medioectal lobe ca. as long as outer lobe (Figure 12t). Cercus only slightly curved ventrally in lateral view (Figure 15w), with row of 5 ventral tubercles along venter of dilated distal portion and with tip slightly upturned; in dorsal view converges along basal 0.70 with opposite cercus, then approximately parallel to it

along distal 0.30 (Figure 14o). Epiproct extends to 0.8 of cercus length, with apex slightly concave and as wide as 0.36 of its basal width (Figure 16u).

Dimensions. Total length 48.9; abdomen length 31.1; Fw length 38.6; Hw length 37.1; Hw maximum width 11.4; cercus length 2.05; epiproct length 1.65; epiproct maximum width 1.1; epiproct subapical width 0.4.

Diagnosis

Male of *O. teres* shares combination of hamule with outer branch bent ventrally over inner branch and epiproct apex relatively narrow, subapically less than 0.45 of its basal width, only with *O. cultriformis*, *O. philipi*, and *O. tambopatae*. It differs from *O. cultriformis* and *O. philipi* by the grooved ventral surface of outer branch of hamule (Figure 11u; versus smooth, Figure 11j, r), and further from *O. cultriformis* by shape of vesica spermalis basal portion of distal segment in ectal view, with maximum width at level of distal end (Figure 13t; versus maximum width at about mid-length, Figure 13j), and from *O. philipi* by pterothorax reddish brown with yellow stripes (Figure 2x; versus pterothorax marbled, Figure 2v). It can be distinguished from *O. tambopatae* by hamule inner and outer branches forming a rounded open curve between them (Figure 11u; versus an acute angle, Figure 11t), and by distal segment of vesica spermalis with basal sclerotized portion as long as its maximum width (Figure 13t; versus much longer than its maximum width, Figure 13t) and distal outer membranous lobe ca. as long as distal medioectal membranous lobe and distinctly shorter than basal sclerotized portion (Figure 12t; versus ca. twice as long as distal medioectal membranous lobe and ca. as long as basal sclerotized portion, Figure 12t).

Female unknown.

Distribution and biology

Orthemis teres is so far known only from the holotype from Bolivia (Figure 22), and nothing is known about its preferred habitat.

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